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The Mixed Waste Management Facility

Design Basis Integrated Operations Plan (Title I Design)

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Preface

The Mixed Waste Management Facility (MWMF) will be a fully integrated pilot-scale facility for the demonstration of low-level organic mixed waste treatment technologies. It will link proven bench-scale technologies to the deployment and operation of full-scale facilities anticipated in response to the Federal Facilities Compliance Act (FFCA). The scope of the MWMF is to design, construct, and start up the systems required for integrated demonstration of the primary waste treatment technologies, including receiving, feed preparation, primary treatment and primary treatment support, final forms, shipping, off-gas, and water treatment systems.

The purpose of this document is to establish the basis by which the MWMF systems will be operated to meet the demonstration mission. At the time of this initial writing, the MWMF Project is in the preliminary design stage. The information herein represents the baseline design and operations philosophy. As design proceeds to the final design and construction stages, this document will be revised to reflect current information.

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List of Acronyms and Abbreviations

ALARA	as low as reasonably achievable
BACT	best available control technology
BDAT	best demonstrated available technology
Btu	British thermal unit
CCTV	closed-circuit television
CEQA	California Environmental Quality Act
cm	centimeter
DOE	U.S. Department of Energy
DRE	Destruction and Removal Efficiency
DTSC	Department of Toxic Substances Control
DWTF	Decontamination and Waste Treatment Facility
EDO	environmental duty officer
EOG	Environmental Operations Group
EPA	U.S. Environmental Protection Agency
ES&H	environment, safety and health
FSP	facility safety procedure
g	gram
gal	gallon
h	hour
HEPA	high-efficiency particulate air
HLW	high level waste
HVAC	heating, ventilation and air conditioning
HWM	Hazardous Waste Management
I&C	Instrumentation and Control
LDR	Land Disposal Restrictions
LFP	Liquids Feed Preparation
LLNL	Lawrence Livermore National Laboratory
LLMW	low-level mixed waste
LLW	low-level (radioactive) waste
MEO	Mediated Electrochemical Oxidation
µCi	microcurie
mm	millimeter
mrem	millirem
MSO	Molten Salt Oxidation
MWMF	Mixed Waste Management Facility
nCi	nanocurie
NEPA	National Environmental Policy Act
OCM	operations control manager
OGT	Off-Gas Treatment
ORA	operational readiness assessment
OSP	operational safety procedure
OSR	operational safety requirement
OTP	operational test procedure

PAC	process acceptance criteria
PE	Plant Engineering
PM	project manager
POHC	principle organic hazardous constituent
POIV	pre-operational integrated verification
PT&S	Process Transport and Storage
QA	quality assurance
QAP	Quality Assurance Plan
RAM	reliability, availability and maintainability
RD&D	Research, Development and Demonstration
SAR	Safety Analysis Report
SFP	Solids Feed Preparation
SOP	system operating procedure
TCLP	toxicity characteristic leaching procedure
TRU	transuranic
UC	University of California
UTS	Universal Treatment Standards
WAA	waste accumulation area
WAC	waste acceptance criteria
WAP	waste analysis plan
WBS	work breakdown structure
WDR	Waste Disposal Requisition
WSC	waste screening criteria
WT	Water Treatment
XOG	Experimental Off-Gas treatment

Definitions

Accuracy. The degree of conformity of a measured, generated, or displayed value to a known standard or quantity which has traceability to a national standard or natural physical constant.

Calibration. The comparison of a measurement standard or instrument of known accuracy with another standard or instrument to detect, correlate, report, or eliminate by adjustment, any variation in the accuracy of the item being compared.

Facility Equipment. Equipment which is part of the building and utilities. Examples: fire sprinkler, electric power, lighting, structure, house air, etc. Facility equipment may also be termed conventional facility or building equipment.

Failure. The inability of a system, subsystem, component, or part to perform its required function within specified limits, under specified conditions for a specified duration.

Hazardous Waste. Wastes considered by the U.S. EPA or California DTSC to pose a danger to people or the environment; wastes that are either listed as hazardous by EPA or DTSC, or exhibit the hazardous characteristics of ignitablity, corrosivity, reactivity, or toxicity, as defined by EPA and DTSC.

Incineration. A set of treatment technologies defined by EPA in which the organic constituents in waste are oxidized at high temperature in an open flame, reducing the waste to ash.

Low Level Waste. Waste that is not high level waste (HLW, highly radioactive reprocessing wastes requiring permanent isolation), transuranic waste (TRU, wastes containing >100 nCi/g of alpha-emitting isotopes with atomic numbers greater than 92 and half-lives greater than 20 years), spent fuels, or uranium or thorium mill tailings.

Maintenance Record. Any record documenting the maintenance of equipment.

Mineral. In the context of a feed stream, the inorganic compounds present in the feed stream that are not removed by feed preparation systems. Examples included in the definition are kaolin (in paper), glass fragments and steel filings. Large objects such as bolts are excluded.

Mineral residue. The principal inorganic residue, exclusive of salt residue as defined below, remaining after organic components of the feed have been oxidized by the treatment processes. This definition includes oxides, nitrates and free metals.

Mixed Waste. Waste containing both radioactive and hazardous components as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act, respectively (DOE Order 5820.2A).

Pedigree. The processing history of a batch of material within the MWMF; the recorded purity of the processing history of a material. Material would have a pure pedigree if it is traceable directly through a linear sequence of processes to a single batch of prepared feed.

Preventive Maintenance. The actions performed in an attempt to retain an item in a specified condition by providing systematic inspection, test, and servicing for the detection and prevention of incipient failure.

Primary Treatment System. A treatment system having the function of destroying most or all of the organic constituents of the waste or surrogate feed. Molten Salt Oxidation (MSO) and Mediated Electrochemical Oxidation (MEO) are the two primary treatment systems in the initial MWMF configuration.

Salt residue. Primarily sodium chloride and sodium fluoride resulting from the treatment of halogenated organics. In the case of MSO salt residue, some sodium carbonate will accompany the halide salts. Also included is sodium carbonate waste generated upon refurbishment or decommissioning an MSO unit.

Secondary Stream. A stream of material that is generated within the MWMF as a by-product of a treatment system. Secondary streams from the treatment of surrogate are not waste until they have no more useful demonstration or testing purpose within the MWMF or are discarded by the MWMF.

Special Equipment. Equipment specific to the MWMF processes: tanks, reactor vessels, pumps, etc.

Spiking materials. Materials of special interest that are added to either a surrogate or waste feed stream to allow experimental determination of the fate of this material during treatment. Materials used as tracers for residence time distribution or partitioning studies are also included. These will typically be hazardous, radioactive, or surrogate species that are added in minority quantities to the feed stream matrix. They may also include nonhazardous materials of demonstration interest that were under-represented in a prepared batch of waste feed.

Surrogate. A batch or stream of material prepared from materials that contain no waste that is used to simulate waste; a specific compound or material that substitutes for and simulates the behavior of a specific compound, material, or group of compounds or materials. The surrogate material must be less hazardous, less radioactive, simpler, fewer in number, or meet regulatory requirements more easily than the materials being represented.

Treatment Train. The series of systems within the facility needed to demonstrate the complete processing and treatment of waste from where it enters the MWMF to where all by-products, residues, and secondary streams have been acceptably treated and are acceptable for discharge or disposal.

Waste. Any material or manufacturing by-product that has served all of its intended uses or has been discarded, especially material that has been designated as waste by Hazardous Waste Management (HWM), that is transferred to the MWMF. Includes hazardous waste, mixed waste, and any non-usable liquid or solid secondary stream material that results from the treatment of waste. Mixtures that contain some fraction of waste are waste themselves.

Working Standard. A standard used to calibrate measuring and test equipment.

Executive Summary

The Mixed Waste Management Facility (MWMF) will be a fully integrated, pilot-scale facility for the demonstration of low-level, organic-matrix mixed waste treatment technologies. It will provide the bridge from bench-scale demonstrated technologies to the deployment and operation of full-scale treatment facilities. The MWMF is a key element in reducing the risk in deployment of effective and environmentally acceptable treatment processes for organic mixed-waste streams.

The MWMF will provide the engineering test data, formal evaluation, and operating experience that will be required for these demonstration systems to become accepted by EPA and deployable in waste treatment facilities. The deployment will also demonstrate how to approach the permitting process with the regulatory agencies and how to operate and maintain the processes in a safe manner. This document describes, at a high level, how the facility will be designed and operated to achieve this mission. It frequently refers the reader to additional documentation that provides more detail in specific areas.

Effective evaluation of a technology consists of a variety of informal and formal demonstrations involving individual technology systems or subsystems, integrated technology system combinations, or complete integrated treatment trains. Informal demonstrations will typically be used to gather general operating information and to establish a basis for development of formal demonstration plans. Formal demonstrations consist of a specific series of tests that are used to rigorously demonstrate the operation or performance of a specific system configuration.

Surrogates and waste will be used to conduct the demonstration system tests. Surrogates, prepared from fresh materials with no waste content, allow efficient coverage of a wide range of feed compositions, and can be prepared and characterized with more precision than waste. After obtaining appropriate regulatory approvals, testing with waste, prepared from Lawrence Livermore National Laboratory's (LLNL's) waste inventory, substantiates the surrogate results and demonstrates robustness to the peculiarities of waste. The technology evaluation strategy, demonstration plans, test plans and individual run plans orchestrate the complete evaluation of a technology, including the feed required, sampling needs, data analysis requirements and system configurations.

The MWMF will be operated to make maximum use of facility resources for these demonstrations. At any one time, a single technology demonstration will have priority and will take precedence for all facility resources needed for its demonstration. Supporting systems will be configured to provide feed, accept residues, and collect and analyze samples and data in support of the primary demonstration. Other system operations may be allowed, as coordinated through the Operations Manager, only if they do not conflict with the primary demonstration.

The MWMF will be operated in compliance with all federal, state and local regulations regarding safety of personnel and the environment. At LLNL, Environment, Safety and Health (ES&H) compliance is a line management function—the line of responsibility is well defined and extends from the working level through to

the LLNL Director. The MWMF Operations Manager is the primary point of focus for coordinating ES&H management during operation of the MWMF.

ES&H objectives are met through careful equipment design (following QA procedures during design), the use of approved procedures for operating equipment, and training and certification of MWMF staff. Contingency plans assist personnel in minimizing hazards to human health and the environment from accidental releases of hazardous materials from the MWMF. Finally, closure plans describe how to safely conduct clean closure of each system at the end of its operating life or at any time during its active life.

1.0 Introduction

The purpose of this document, the *Design Basis Integrated Operations Plan*, is to describe how the systems which are to be installed in the Mixed Waste Management Facility (MWMF) will be operated as integrated technology combinations or fully integrated treatment trains to meet the demonstration mission. The design basis, design, and operation of individual processing and treatment systems are described in other Project documents (*MWMF System Design Requirements,*[1] *MWMF System Design Descriptions,*[2] etc.). The systems explicity addressed in this document are Work Breakdown Structure (WBS) 1.4 Feed Preparation Systems, WBS 1.5 Waste Processing Systems, WBS 1.6 Process Support Systems, and WBS 1.1.4 Environment, Safety and Health. Other elements provide for management support, systems integration, permitting, startup, and activation.

This document is organized to cover three primary subjects—mission, operations, and responsibilities. First, the mission of the MWMF is discussed, and the general strategy which will accomplish the evaluation of the installed technologies is presented. Second, those elements needed to perform integrated demonstrations are discussed. These include the operating basis, and material and operational flow. Third are those elements necessary for the responsible operation of the MWMF. These include responsibilities and authorities, assurances, contingency plan, and project closure.

Chapter 2 briefly discusses the scope and objectives of the MWMF Project to provide background and the high-level basis for demonstration of the technologies. A more detailed discussion of the Project scope and objectives can be found in the *MWMF Draft Final Project Plan*,[3] and the *MWMF Project Management Plan.*[4]

Chapter 3 addresses the technology evaluation strategy. The strategy provides a high-level outline and general strategy that will be employed in demonstrating the waste treatment technologies and process support technologies, and the treatment trains in which they are incorporated.

The operating basis, described in Chapter 4, together with the material and operational flow discussion in Chapter 5, provides the basic plan for operation of the MWMF. These describe the types of materials used in the demonstrations and how they are handled, characterized, and treated in the facility.

Chapters 6 and 7 discuss responsibilities and assurances that ensure systems will be designed, integrated and operated to demonstrate, test, and evaluate technologies in a safe, environmentally acceptable, and reliable manner. These include the responsibilities for implementing a safety methodology from design, construction, and activation activities through to facility operations. This is followed by a discussion of the assurances programs, which ensure that safety and quality objectives are met.

Chapter 8 discusses contingency planning, which is designed to assist personnel in minimizing hazards to human health and the environment from earthquake, fires, explosions, or any release of hazardous or mixed-waste constituents to the atmosphere, soil, or surface water from the operations conducted within the MWMF.

Finally, Chapter 9 summarizes the scope and use of closure plans to effect clean closure of each waste management unit at the end of its operating life or partial closure at any time during its active life.

Companion documents should be consulted for additional information. Project management documents include the *MWMF Quality Assurance Plan*,[5] *MWMF Primary Criteria*,[6] and the *MWMF Technology Selection & Implementation Plan*.[7] Technical design information is found in the *MWMF Conceptual Design Report*.[8] More detail on the training, closure, and contingency plans will be found in future documentation (References 9, 10, and 11 respectively).

2.0 Project Scope and Objectives

The MWMF is a key element in reducing the risk in the deployment of effective and environmentally acceptable treatment processes for organic mixed-waste streams. The Project will link mature bench-scale technologies that have been developed principally under the DOE R&D program with full-scale treatment facilities, and provide data for the effective scale-up of the successful processes to full-scale facilities. In response to the increasing environmental concerns over employing incineration as a treatment technology, this project will focus on demonstrating a variety of complementary treatment technologies that are environmentally acceptable alternatives to incineration, and it will evaluate these treatment technologies relative to the Federal and State treatment standards that call for incineration.

The testing, evaluation, and demonstration of these technologies will provide the engineering data, operating experience, and performance data sufficient to:

- Establish the ranges of waste composition and characteristics, operating parameters, and equipment configurations that produce acceptable (or unacceptable) performance.
- Establish a full technical evaluation or benchmarking for the systems.
- Support an application to U.S. Environmental Protection Agency (EPA) for determination that the system is a Best Demonstrated Available Technology (BDAT) or meets Universal Treatment Standards (UTS).
- Allow informed technical decisions to be made by technology vendors, DOE managers, regulators, and treatment facility managers and design engineers regarding commercializing and deploying these systems in waste treatment facilities.
- Provide the data needed to obtain permits from regulators for the construction and operation of future treatment facilities.
- Allow engineering scale-up, design construction, and operation of these systems for a full-scale treatment facility.

Testing will initially be conducted using surrogate feed materials to simulate low-level organic matrix wastes. After approval is obtained from the appropriate regulatory agencies, testing will be conducted using waste. Waste feeds proposed for demonstration within the current scope of the MWMF demonstrations are land disposal restricted, organic-containing, low-level mixed wastes. Feed composition emphasis will be guided by the needs of the DOE complex with all mixed waste obtained from representative organic-containing mixed waste in LLNL's inventory.

The MWMF Project is responsible for selecting the initial suite of technologies for inclusion in the pilot plant; for design, procurement, fabrication, installation, start-up and activation of the waste handling and treatment equipment; for obtaining the necessary permits to operate the facility and equipment; and for completing the required safety, operations, and other activities leading to a successful operational readiness assessment. The facility will integrate all phases of waste handling and treatment: receiving and characterization, feed preparation and transport, treatment processes, and final forms. By developing an integrated infrastructure capable of supporting a full range of waste streams and treatment technologies, the MWMF will

provide a national test bed for the demonstration of advanced technology systems for processing and treating organic-containing low-level mixed wastes within an integrated treatment facility environment.

The advanced technologies selected for testing and evaluation will be demonstrated either alone or as key parts within integrated technology combinations or fully integrated treatment trains. Technologies for demonstration include primary treatment processes for the destruction of hazardous organic constituents (initially Molten Salt Oxidation [MSO] and Mediated Electrochemical Oxidation [MEO]), a subset of the processes for treating secondary streams (initially advanced wet scrubbing of off-gas, ceramic final forms, and polymer encapsulation final forms), and a subset of the technologies for handling and preparing waste (initially telerobotic solids sorting). The advanced treatment technologies have capability to treat many wastes for which incineration is currently prescribed by EPA as BDAT.

Support systems, consisting of state-of-the-art established technologies, will complement the advanced technologies to provide complete treatment trains and a fully integrated treatment facility environment and infrastructure. Support systems include the supervisory instrumentation and control (I&C) system, and the balance of the handling, feed preparation, and secondary-stream treatment systems.

In addition to providing the physical facility and equipment, key elements of the project scope include laying the foundation for the subsequent permitting, NEPA documentation, public participation, and technology transfer for development of a full-scale operating facility. The project activities will provide excellent opportunities for technology transfer to the commercial sector. Key to the project scope is integration of industrial partners into all aspects of mixed-waste treatment, including operations.

An expected product of the MWMF demonstrations is transfer of the operating data to industry so that a commercially operated mixed-waste treatment capability can be established in California and in other states. These data include the cost of permitting, installing, and operating a mixed-waste treatment facility in the 1990s. Such capability does not now exist in California, where hospitals and universities create mixed waste in diagnostic, therapeutic, and research endeavors, and commercial treatment capacity is needed soon to avoid affecting their vital programs.

3.0 Evaluation Strategy

This chapter describes the general strategy and outline of operations for evaluating the systems to be demonstrated within the MWMF. More detailed demonstration plans, test plans, and run plans will be prepared subsequent to final design.

For each technology, a demonstration plan will be prepared to address technology system and/or treatment train demonstration objectives, feed material types, scope and approximate schedule of test series to be conducted, and measurements required. Specific goals of each test series (typically waste stream specific) required to accomplish demonstration objectives will be addressed in a test plan. Details of each test to be conducted within a series will be documented in a run plan, which will include facility and equipment configuration, line of responsibility, operating procedures, and data acquisition requirements as discussed below.

3.1 General Objective

The systems to be evaluated in the MWMF are alternatives to established methods for the processing and treatment of low-level mixed wastes and their by-products. These include specific technology systems and subsystems that have been proven at bench scale, integrated technology combinations, and fully integrated treatment trains. Testing in the MWMF will provide, in an integrated pilot-plant scale treatment environment, the additional engineering test data, formal evaluation, and operating experience on a wide range of feed materials, which will be required for these systems to become accepted by EPA and deployable in future waste-treatment facilities.

3.2 Demonstration Configurations

Formal demonstration tests will be conducted on systems and subsystems configured as described below to meet specific test objectives. At any given time, one system will be the focus of these tests and, therefore, of the facility operations. Other systems may be operated subject to operational constraints. Systems that are not the focus of the testing will be operated as needed to support the demonstration test objectives.

Technology Systems and Subsystems. Tests will focus on one or more specific technologies, which include integrated primary waste treatment systems (i.e., the complete MSO system or MEO system), key subsystems of primary waste treatment systems (e.g. MSO reactor, MEO silver recovery unit), and those process support systems and subsystems that are demonstration technologies (e.g., robotic sorting in Solids Feed Preparation, acidic urea de-NO_X scrubbing in Experimental Off-Gas, ceramic final waste forms in Final Forms).

Integrated Technology System Combinations. Tests will focus on an integrated combination of technologies that together accomplish a certain processing or treatment

objective. This may be a combination of both demonstration technologies and conventional technologies. An example would be molten salt oxidation, mineral residue separation, and salt separation as accomplished by the MSO System, plus evaporation and drying of brine as accomplished by the Water Treatment System. Such a technology combination could be inserted into a facility that already had its own processes to prepare waste, treat off-gas, stabilize mineral residues, and immobilize salt.

Integrated Treatment Trains. Tests will focus on the demonstration of fully integrated treatment trains including all systems within the facility needed to prepare and treat waste from its point of entry into the facility to the point at which all products, residues, and secondary streams leave the facility having acceptable characteristics.

3.3 Regulatory Acceptability

Waste treatment systems will be tested in order to evaluate them relative to Federal, State and local treatment standards, residue stabilization requirements, and effluent requirements. Ideally, the demonstration waste treatment systems under evaluation will be able to acquire a designation by EPA of BDAT, or "Technology Equivalent to BDAT" for a range of waste types and compositions. Extensive test data will be required to support a petition to EPA for such a determination.

The requirements for designating a treatment system as BDAT or as meeting UTS are specific to both the treatment system and the waste streams to be treated. The MWMF will work closely with Department of Toxic Substances Control (DTSC) and EPA to design tests that will allow such a determination. The requirements for a successful petition may include showing that the treatment products and residues have contaminant concentrations less than UTS, the treatment products and residues are land disposable, the Destruction and Removal Efficiency (DRE) is equivalent to that obtainable by the currently prescribed BDAT (e.g. 99.99% DRE for incineration), or a combination of these or other specifications.

Deployment of a waste treatment system in a treatment facility will require permits from regulators (i.e., EPA, DTSC, local, etc). A favorable determination for the treatment system as published by EPA will be of considerable value. The regulators will also likely want to review data to be assured the proposed treatment system will work satisfactorily for the specific wastes subject to the permit application, and within the specific circumstances and environment in which the proposed treatment facility will operate. Demonstration of a treatment system in the MWMF will provide this data, which will include showing reliability and response to transients and upsets, and demonstrating that the system can meet local requirements for air quality and waste water pretreatment (sewerability). The MWMF treatment system demonstrations will use as targets the local requirements such as those standards established by the City of Livermore, California, for water discharged to the sewer, and by the Bay Area Air Quality Management District for air emissions to the atmosphere.

3.4 Technical Evaluation

Testing of technology systems and subsystems, integrated technology combinations, and fully integrated treatment trains will provide baseline technical evaluation engineering data and operating experience to waste treatment facility designers. These data will allow facility designers to specify systems for their appropriate waste streams, design for the appropriate facility scale, obtain permits from regulators, and construct and operate future facilities. The engineering data will include feed handling/preparation and process performance (rates and compositions of input and output streams) over a wide range of waste compositions and operating parameters. Operating experience and information will include ease of operation, stability to upsets, and reliability, availability, and maintainability (RAM) data. The testing of waste treatment systems will also provide benchmark data. Benchmarking, as described in one DOE report,[12] is intended to supply DOE managers with information for evaluating and selecting technologies.

3.5 System Testing Objectives

Tests will be performed on a wide range of feeds to determine the envelope of waste composition that can be acceptably treated by a system, and the envelope of system operating conditions that produces acceptable treatment of a given feed composition. Additional tests will complete the full technical evaluation, including transient performance and technical process data for scale-up or confidence-enhancing information. Testing will also determine the ease of operation, reliability, and maintainability of systems.

Treatment performance for a series of feeds of different compositions will be assessed by measuring, under near nominal to optimal operating conditions, the rates and concentrations of species of interest in:

- each input stream,
- each output stream,
- each internal accumulation of material, and
- Leachate concentrations from final waste forms as determined by Toxicity Characteristic Leaching Procedure (TCLP). (The basic standard against which leach resistance will be judged is the TCLP, but supplemental leach testing may include the WET, TTLC and ALT procedures.)

These measurements will be sufficient to evaluate:

- material balances on total mass, elements, and constituents of interest,
- DREs for Principal Organic Hazardous Constituents (POHCs) and other feed species of interest, and
- performance relative to the UTS.

The species of interest in each stream will vary according to the feed and treatment system and will be part of each individual run plan.

Treatment performance over a range of operating parameters will be assessed by measuring, for a few representative feed compositions, the same quantities as above.

Transient performance data, including time to reach steady state, response to changes in operating parameters, stability during upsets, response to temporal

variations in waste composition, and response to deviation from nominal conditions such as loss or reduction in flow or power, will be assessed in tests designed specifically for these objectives, using a few representative feed compositions. Sampling and data acquisition will be appropriate to capture the system dynamic response.

The ease of operation, reliability, and maintainability of systems will be evaluated based on all of the testing experience in aggregate. If required, one or more long, continuous operation runs (up to 100 hours) for each system on one or more representative feeds will provide additional experience and information.

The duration of each test will be sufficient to accomplish the demonstration objectives of whatever system(s) are the focus of the test. Test durations are expected to run from one hour (e.g. parametric tests of destruction efficiency versus excess oxygen in the MSO reactor) to five shifts (e.g. full treatment train test on a campaign of feed under nominal conditions), to 100-hour operability tests of systems.

3.6 Run Plans

After the MWMF and its systems are activated, demonstration testing will be conducted as guided by formal written run plans. All run plans will be approved by the Operations Manager and other appropriate individuals. Each will address the specifics of the run to be conducted within a test series, including:

- Introduction, including purpose for the run and its individual studies.
- Responsible person(s).
- Statement of prioritized run objectives, including which system is the primary focus of the run, which systems have secondary priorities, and which systems are needed for support.
- Facility configuration and high-level flow diagram(s) indicating which systems (including support systems and utilities) are involved and the role(s) each plays in the run.
- Studies to be conducted:
  — Feed(s) composition(s) and rate(s)
  — Operating conditions / parameters.
- Run schedule or time-line.
- Data acquisition requirements.
- Any unusual operating requirements, especially those that have potential ES&H implication, and contingency plans to mitigate potential accidents.

The following are needed for each individual system:

- Equipment configuration, especially noting anything specific to the run (can refer to existing descriptions of nominal equipment configurations).
- Run plan details specific to the individual system.
- Run start criteria (the state of the system to be initially achieved in order to convene a successful run).
- Operating procedure, including startup and shutdown procedures (can refer to system operating manuals), especially operating notes specific to this run.

- Response to off-normal conditions (can refer to system operating manuals), including off-normal conditions that are especially likely for this specific run.

3.7 Feed Materials

Demonstrations of treatment systems in the MWMF will target a spectrum of organic-containing waste compositions. It is important that test feed material cover a wide range of compositions and characteristics to ensure the demonstration data are useful to many users (e.g., facility designers), each with specific waste treatment and information needs.

System tests will initially be conducted using surrogate feed material. After approval is obtained from the appropriate regulatory agencies, system tests will be conducted using waste. Surrogates allow efficient coverage of a wide range of feed characteristics and compositions. Surrogates are also prepared and characterized with more precision than waste, making analyses and data interpretation more quantitative. Testing with waste substantiates the surrogate results and demonstrates robustness to the peculiarities of waste. Feed compositions will be specified to evaluate system performance over the full range of wastes for which the system is targeted.

Surrogates will be prepared by Solids Feed Preparation and Liquids Feed Preparation from entirely fresh materials with no waste content. Surrogates may contain nonhazardous and hazardous organics and metals, radionuclides, organic and inorganic solids, and water. Surrogates simulate the physical and chemical properties of wastes of interest. Surrogate compositions will cover the range of waste composition for which the treatment system has been targeted for demonstration.

Ideally, the chemical constituents of surrogates should not react with one another in unforeseen ways, they and their reaction products should be conveniently detectable, and they should not alter key operating conditions from those expected under actual treatment conditions. Surrogate batches must be consistent in composition so that results from test series are easily comparable. Surrogate formulations will be selected based on DOE guidance (Refs. 13–16), EPA guidance, and engineering test objectives.

Wastes will be prepared by Solids Feed Preparation and Liquids Feed Preparation from LLNL's inventory of organic-containing low-level mixed waste held by LLNL's Hazardous Waste Management Division. These wastes may be spiked with species or materials including hazardous metals, hazardous organics, radionuclides, or other materials.

3.8 Measurement Procedures

Appropriate standards and methods will be applied to data-gathering activities. Analytical data obtained for regulatory purposes will use the waste-handling protocols and analytical procedures outlined by the EPA in *Test Methods for Evaluating Solid Waste, Physical Chemical Methods*[17] and *The Compendium of Methods for the Determination of Toxic Organic Compounds in Ambiant Air*.[18] Methods for stack gas sampling should be

consistent with *Appendix A of 40 CFR 60,*[19] and may make use of recommendations found in *Characterizing Containerized Mixed Low-Level Waste for Treatment - A Workshop Proceedings.*[20] QA / QC procedures recommended by DOE's Mixed Waste Integrated Program (MWIP) in *MWIP Guideline for Benchmarking Thermal Treatment Systems for Low-Level Mixed Waste*[9] and *Data Quality Objectives: Evaluation of Thermal Treatment Processes*[21] will be applied as appropriate.

3.9 Reporting of Results

Description of the actual test procedures, configurations, observations, and data will be documented, using a combination of process run sheets, lab notebooks, electronic data acquisition, and analysis reports. This documentation will be maintained by the responsible Principal Investigator(s) for the test. Results and conclusions will be formally documented in reports. These formal test reports will be compiled by the Operations Manager and will be approved by the operations and scientific managers responsible for the systems being reported. Copies of the data and formal reports will be placed in the QA records file.

4.0 Operating Basis

The MWMF will be operated for the purpose of testing, evaluating, and demonstrating advanced waste treatment technologies, technology combinations, and complete treatment trains within an integrated treatment facility environment. Demonstration systems will be evaluated for their ability to treat and process organic-containing low-level mixed waste in a safe, environmentally acceptable, reliable, and cost-effective manner. The end goal of the demonstrations is a determination that the treatment system meets EPA UTS or BDAT equivalency. This chapter provides the basis for operating the MWMF to accomplish this mission.

Facility and systems activation testing will be performed to debug the systems and interfaces, demonstrate nominal operation of the systems and interfaces, and demonstrate safe operation and preparedness for off-normal and emergency conditions. Activation tests will use surrogate feed materials and will be of short duration.

Normal operation will consist of informal tests using surrogates, and formal tests using both surrogate and waste feeds. Informal tests will be used to establish operating conditions and waste parameters so that the formal tests can be conducted efficiently. Formal tests will produce the data required to evaluate the treatment system, in accordance with the Evaluation Strategy (Chapter 3). Surrogates will cover the range of compositions for each of the waste types for which the treatment systems are targeted. Wastes will be obtained from LLNL's Hazardous Waste Management (HWM) Division which are representative of much of the low-level mixed waste in the DOE complex.

The Operations Manager will coordinate priorities for all system demonstrations. The highest priority system will take precedence for all MWMF resources needed for its demonstration. Initially, facility operations will be conducted to test only one primary treatment system at a given time. Later, facility operations will allow multiple primary treatment systems to be tested simultaneously on the same or different feeds.

The MWMF and the equipment within it will be operated in compliance with all applicable federal, state, and local regulations pertaining to the health and safety of the public, employees, and the environment. In addition, the MWMF will be operated in compliance with all DOE, University of California, and LLNL requirements.

4.1 Feed Streams

Two types of material will be fed to the primary treatment processes and their treatment trains. The first type, surrogate, is prepared entirely from fresh materials, including hazardous and radioactive materials, and has no waste content. This may be spiked with additional metal, organic, or radionuclide species of interest. The second type, waste, is authentic low-level mixed waste prepared from requisitioned waste held by LLNL's HWM Division.

Model waste feed streams, listed in Table 4-1, are defined in the *MWMF Definition of Model Waste Streams*[22] for the purpose of establishing a basis for material balances and design for the MWMF primary treatment systems and upstream and downstream systems. These feed streams are also used as a basis for operation of the MWMF.

Stream number	Description	Treatment Processes
1	Halogenated Solvents	MEO, MSO
2	Nonhalogenated Solvents	MEO, MSO
3A	Trimsol Emulsion	MEO
3B	Trimsol Oil	MSO
4A	Predominantly Organic Solids	MSO
4B	Cellulosics	MEO

Table 4-1. Model waste streams are proxies for the wide range of possible feeds to the primary treatment processes.

The model waste streams serve as proxies for the wide range of feed compositions that can be selected and/or blended to supply a test. Most feeds to the primary treatment processes will have their characteristics illustrated by one or a combination of the model streams, since they are defined to cover a large range of chemical and physical properties, while still conveying realistic average information. The model compositions are consistent with a compilation of available data on all containers of organic-containing low-level mixed waste transferred to LLNL's HWM Division between January 1991 and June 1992 as reported in the *MWMF Analysis of Initially Selected LLNL Mixed Waste Streams.*[23] As individual tests and test feeds are specified more precisely in the demonstration plan or test plans, additional model streams may be defined if needed to cover the feed characteristics.

4.2 Acceptance Criteria

Waste Screening Criteria (WSC) for the MWMF and Process Acceptance Criteria (PAC) for each of the individual systems have been defined for the purpose of establishing limits on materials which may be brought into the MWMF and processed by the individual systems. WSC are herein documented as are the PAC that are globally applicable to the MWMF and to all the MWMF systems. Individual process system PAC are found under separate cover as part of the *MWMF System Design Requirements.*[1]

All reagents, materials to be used for generating surrogates, and wastes enter the MWMF through the MWMF Receiving system. All spent consumables and equipment, processed waste ready for land disposal, and process-generated wastes for return to HWM leave the MWMF through the MWMF Shipping system. All waste transferred into and out of the MWMF will be through LLNL's HWM Division.

The source of reagents and materials for use in the MWMF will be no different than for any other experimental facility at LLNL and will include LLNL's Material Distribution Division, Materials Management Section (radioactive materials), and the

Chemical Exchange Warehouse. The destination for unused materials will include LLNL's Materials Management section and Chemical Exchange Warehouse. Utilizing the Chemical Exchange Warehouse minimizes generation of hazardous waste by using chemicals that have been discarded by other LLNL programs and would otherwise become waste, and by giving other LLNL programs the opportunity to use the MWMF's surplus chemicals before they are declared waste.

4.2.1 Global Acceptance Criteria

Acceptance criteria applicable to the MWMF facility and to all MWMF systems are as follows:

- All material will be in sound, intact, sealed approved containers designated for the particular material with external surfaces free of contamination. (*Free of contamination* is defined as radioactivity levels below the general surface contamination limits of Table 33-3 of the *LLNL Health & Safety Manual*[24].)
- All radioactive materials, including fresh radioisotope spiking materials, radioisotope-containing surrogates, and radioactive and mixed waste must be characterized as follows (see U.S. Department of Energy Interim Mixed Waste Inventory Report: Waste Streams, Treatment Capacities and Technologies, April 1993, DOE / NBM-1100, Section 2.4.1):
  - TRU (rad wastes containing >100 nCi / g of alpha-emitting isotopes with atomic numbers greater than 92 and half-lives greater than 20 y)
    - TRU-RH (remotely handled ≥200 mrem / h at container surface)
    - TRU-CH (contact handled ≤200 mrem / h at container surface)
  - LLW (all rad wastes that are not high-level wastes, TRU, spent fuels, or U or Th mill tailings)
    - LLW-RH-Alpha (remotely handled if >200 mrem / h at container exterior surface; alpha radionuclide containment recommended if alpha content >~10 nCi / g)
    - LLW-RH-NonAlpha (remotely handled if >200 mrem / h at container exterior surface; alpha content <~10 nCi / g)
    - LLW-CH-Alpha (contact handled ≤200 mrem / h at container exterior surface; alpha radionuclide containment recommended if alpha content >~10 nCi / g)
    - LLW-CH-NonAlpha (contact handled ≤200 mrem / h at container exterior surface; alpha content <~10 nCi / g)
- All material will be accompanied with the following information:
  - Its point of origin or source.
  - Designation of waste or nonwaste (fresh material, surrogate, process product or residue from treatment of surrogate).
  - Material weight and volume.
  - Number, size and description of material containers.
  - Identification of gross material matrix (phase and general characteristics).
  - Available pertinent information on composition and characteristics.

— Material Safety Data Sheet (MSDS) for those materials that require one.
— Identification of personnel responsible for material.

4.2.2 Waste Screening Criteria (WSC)

WSC for the MWMF are defined here for the purpose of establishing limits on waste materials which may be brought into the MWMF and processed by the individual systems. MWMF demonstrations are focused on treatment of a certain spectrum of organic-containing mixed wastes. Therefore, screening criteria are established to minimize the amount of waste needed to perform the demonstrations, as a basis for scaling and designing equipment, and to remain within permit limits on facility effluents. Waste that fails to meet the screening criteria will be returned to HWM. The criteria pertinent to wastes for the MWMF are listed below.

Wastes will be accepted into the MWMF only if they satisfy all of the following:

- The waste is managed by HWM (i.e., waste generated by other LLNL facilities will not be accepted directly into the MWMF without first being accepted by HWM as meeting all their Waste Analysis Plan [WAP] criteria).
- The waste was requisitioned by the MWMF Operations management office. (The selected waste's hazardous constituents meet the waste profile required for a pending, scheduled demonstration)
- The waste is in sound, intact and sealed containers approved for, and compatible with, the material contained. External container surfaces must be free of contamination. ("Free of contamination" in this context means having radioactivity levels below the general surface contamination limits specified in Table 33-3 of the *LLNL Health & Safety Manual*[24], with no visual evidence of corrosion, erosion, discoloration, staining, or moisture.)
- The waste container can be handled by hand (<200mrem/h surface dose) and contents should have less than 100 nCi/g of transuranic material.
- All solids waste containers are accompanied by radiographic images of their contents.
- Existing information on the waste indicates that it meets DOE guidelines for low-level mixed waste.
- Existing information on the waste indicates that Tritium concentrations are less than ten (10) µCi/g.
- Existing information on the waste indicates that it contains no free mercury and does not require mercury desorption.
- Existing information on the waste indicates that fifty percent by volume of the waste container contents can be prepared as feed for the installed treatment systems.
- Incoming liquid waste containers contain less than 20% by volume solid/sludges.

4.3 Process Equipment Design

Design of the MWMF will allow for changes in the process and process support systems as changes in demonstration technologies are made throughout the life of the facility. General use utilities (negative air, chilled water, electrical power, etc.) will be sized to accommodate the initial and anticipated future configurations of the MWMF systems.

The MWMF process equipment will be designed with flexibility appropriate to its use in the initial and future configurations of the MWMF systems. This will include testing and evaluating alternative equipment, technologies, sequences and combinations of operations, and material and container variations. Component modularity, as well as commonality in interfaces for material reception or issuance, is desirable.

The design of systems will demonstrate performance, reliability, and ease of maintenance. Also, design of systems will emphasize modularity and flexibility appropriate to relative ease of staging, installation, demonstration, decommissioning, and closure. Design standards will be adopted to the maximum extent possible to ensure commonality throughout the facility. Appropriate redundancy in support systems will be provided so that a single-component failure will not result in an extended delay in operations.

The design of systems will provide for stand-alone, non-conflicting operation. The impact caused by system maintenance, standby operation, or operation of any process technology on the system maintenance, standby operation, or operation of any other process technology will be minimized.

Process systems will be decoupled from other process systems by surge capacity (containers, drums, tanks, etc.) to accommodate long-duration operations, segregation of streams/batches, and analytical chemistry analysis and results.

4.4 Safety Systems Design

All MWMF equipment will be designed, fabricated, and operated in compliance with all applicable federal, state, and local regulations pertaining to the health and safety of the public, employees, and the environment. All MWMF systems will be designed to passively fail-to-safe without presenting a hazard to personnel or the environment.

Safety systems will be implemented using previously proven techniques. The purpose of the safety systems is twofold: (1) to work in conjunction with administrative control procedures to protect personnel and the environment, and (2) to minimize damage to high-value equipment in the event of a failure in process or facility equipment.

ALARA principles will be applied in the design of MWMF equipment and its operation. Materials to be processed in the MWMF are well controlled via acceptance criteria. Safety design features required to achieve a safe work environment while processing these specific materials will be implemented. Remote handling equipment, secondary radiation shielding, etc. will be provided when deemed effective in reducing

industrial hazards and radiation exposure and/or required for effective demonstrations of technology.

4.5 Facility and Systems Activation

The goal of activation is to make the facility, equipment systems, and operations personnel ready for normal facility operation. Procedural documentation will be prepared, engineering acceptance testing and PreOperational Integrated Verification (POIV) testing will be performed, and Operational Readiness Assessments (ORAs) will be conducted. Formal acceptance of the ORAs by the DOE will lead to authority to operate, at which time normal operations, as discussed below, will commence. During normal operations, scientific acceptance testing and process performance and evaluation activities will be conducted. Acceptance Criteria, Off-Normal Operation, and Emergency Operation as defined elsewhere in this Chapter will be in effect during facility and systems activation.

Procedural documentation will guide the operation of the MWMF. Operational Test Procedures (OTPs) and System Operating Procedures (SOPs) will govern the testing of systems equipment and interfaces. Facility Safety Procedures (FSPs), Operational Safety Procedures (OSPs), and personnel training will ensure efficient and safe operations. Where necessary, Personnel Access Control Procedures will be activated.

Engineering debug and acceptance testing activities will verify equipment operation at the subsystem and interface level. POIV testing will extend that testing to include formal verification of subsystem and integrated system operation.

ORAs will be formally conducted by personnel other than those on the MWMF design team. These independent assessments will validate and demonstrate safe operation of the facility equipment. All required regulatory permits will be in place and verified during the ORAs. The review of the ORAs by DOE will lead to the authority to operate the facility using surrogate and/or waste as feed material.

Scientific acceptance testing will be performed using surrogate feeds, will typically be of short duration (1 h to 1 shift [typically 8 h]) and narrowly focused (one system, subsystem, or interface at a time), and will have the scheduling and operational flexibility required for debugging and troubleshooting procedures. Scientific acceptance will conclude with one or more formal checkout tests of medium duration (1 shift to 5 shifts) on both individual systems and full treatment trains.

4.6 Normal Operation

Normal operation will consist of informal tests using surrogates, and formal tests using both surrogates and waste feeds. Informal tests will be conducted to establish operating conditions and waste parameters so that the formal tests can be conducted efficiently. Formal tests will produce the data required to evaluate the treatment system, in accordance with the Evaluation Strategy (Chapter 3) and the demonstration plan, test plan and run plan.

The Operations Manager will coordinate priorities for all system demonstrations. The highest-priority system will take precedence for all MWMF resources needed for its demonstration. Initially, facility operations will be limited to test only one primary treatment system at a given time. Later, facility operations may allow multiple primary treatment systems to be tested simultaneously on the same or different feeds.

The duration and scope of tests will vary according to the specific test objectives. For tests in which the focus is a primary treatment technology or treatment train, the following four outlines of typical formal tests provide a good basis for design and operational planning. Informal tests will resemble any of the first three typical tests, but with less emphasis given to material segregation and downstream processing.

One-shift, single-feed, multiple-operating-parameter test. A single batch of feed is supplied to one primary treatment system for one shift. Multiple studies, perhaps one hour each, are performed during the shift to evaluate different operating conditions, etc. Products from studies are sampled and analyzed separately. Off-gas streams will be sampled and analyzed at least once per study, and treated and released continuously. Each continuously produced liquid or solid product stream will be sampled and analyzed at least once per study and accumulated in a single one-shift batch for each stream. These one-shift product batches are segregated to retain their pedigree and are managed/treated separately by downstream processes. Products that are not continually produced, but accumulate in the primary treatment system (e.g. mineral residue and NaCl in MSO, or AgCl in MEO), are measured by sampling and analysis. When sufficient accumulations have occurred over multiple studies, they are periodically processed by the subsystem (e.g. Salt Recycle or Silver Recovery), yielding a product (e.g. mineral residues or brine) of mixed pedigree. These periodic products go to downstream systems with a requirement to segregate by primary treatment technology.

Two-shift, multiple-feed, nominal-operating-parameter test. Eight differing batches of feed are supplied to one primary treatment system for multiple ~two-hour studies conducted during two consecutive shifts. Each batch is of the same general category of waste or surrogate, but with different composition. Each study will be performed with nominal operating parameters for each feed composition. Off-gas streams will be sampled and analyzed at least once per study, and treated and released continuously. Each continuously produced liquid or solid product stream will be sampled and analyzed at least once per study and accumulated in a single two-shift batch for each stream. These two-shift product batches are segregated to retain their pedigree and managed/treated separately by downstream processes. Products that are not continually produced, but accumulate in the primary treatment system (e.g. mineral residue and NaCl in MSO, or AgCl in MEO), are measured by sampling and analysis. When sufficient accumulations have occurred over multiple tests, they are periodically processed by the subsystem (e.g. Salt Recycle or Silver Recovery), yielding a product (e.g. mineral residues or brine) of mixed pedigree.

These periodically produced batches go to downstream systems with a requirement to segregate by primary treatment technology.

Five-shift, single-feed, multiple-operating-parameter test. A single batch of feed is supplied to one primary treatment system for five ~eight-hour shifts on consecutive working days. Multiple studies are conducted wherein operating parameters are varied, some for one-hour duration, others for one-shift duration. Products from each study are sampled and analyzed separately. Off-gas streams will be sampled and analyzed at least once per study, and treated and released continuously. Each continuously produced liquid or solid product stream will be sampled and analyzed at least once per study and accumulated in a single five-shift batch for each stream. These five-shift product batches are segregated to retain their pedigree and managed / treated separately by downstream processes. Products that are not continually produced, but accumulate in the primary treatment system (e.g., mineral residue and NaCl in MSO, or AgCl in MEO), are measured by sampling and analysis. At the conclusion of the five-shift test, accumulated material will be processed by the subsystem (e.g., Salt Recycle or Silver Recovery), yielding a product (e.g., mineral residues or brine) traceable entirely to the five-shift test. These periodically produced batches are segregated to retain their pedigree and managed / treated separately by downstream processes.

100-hour, single-feed, nominal-operating-parameter test. A technology is continuously operated for ~100 hours to evaluate reliability and ease of operation. Advanced preparations by upstream and downstream systems will be scheduled to make adequate feed and tankage available. Individual studies are not required, but may be conducted. The feed will be either a single batch or multiple batches of consistent composition. Off-gas streams will be sampled and analyzed periodically as needed, and treated and released continuously. Each continuously produced liquid or solid product stream will be sampled and analyzed periodically as needed, and accumulated in one or more batches. Products that are not continually produced, but accumulate in the primary treatment system (e.g. mineral residue and NaCl in MSO, or AgCl in MEO), are measured by sampling and analysis. At the conclusion of the test, accumulated material will be processed by the subsystem (e.g. Salt Recycle or Silver Recovery), yielding a product that is traceable entirely to the 100-hour test. These periodically produced batches are segregated to retain their pedigree and managed / treated separately by downstream processes.

MWMF system operators and equipment will act together to accomplish the following:

- Receive and inspect raw material and mixed waste requisitioned by MWMF personnel for treatment studies.
- Characterize containerized material non-intrusively to determine if the material meets the MWMF WSC, to determine proper routing based on material

composition, and to identify, where possible, any hazards associated with the material.
- Prepare containers for handling and hold them in in-process storage until MWMF systems are ready to perform feed preparation operations.
- Prepare and characterize surrogate and waste feed material for treatment by MWMF primary treatment processes.
- Process surrogate feed material and mixed waste to destroy the organic constituents.
- Manage internally generated secondary streams.
- Segregate streams / batches as needed for process performance analysis and maintenance of "pedigree."
- Segregate clean streams / batches from potentially contaminated streams / batches as appropriate to minimize generation of waste.
- Manage all aqueous streams generated within the MWMF, assigning them as appropriate to storage, MWMF treatment, or transfer to HWM.
- Treat all aqueous streams having demonstration interest within the MWMF to produce sewerable or recyclable water, and solids that are acceptable to the Final Forms System.
- Treat process off-gas and enclosure and hood ventilation exhaust.
- Immobilize process stream residues in final forms.
- Prepare final forms material for acceptance by HWM.
- Decontaminate spent equipment and prepare reject material for acceptance by HWM.
- Perform radiochemical, organic, and inorganic analytical services as required.
- Perform integrated control and monitoring functions to manage efficient and safe startup, operation, shutdown, and maintenance of the processes.
- Perform inventory tracking of materials such as wastes, surrogates, analytical samples, reagents, and residuals.
- Perform engineering measurements and data-gathering activities.

The facility will be operated within the following guidelines:
- Facility activity schedules will typically be maintained within the following guidelines:
  - — Standard operating hours are 7:00 am to 6:00 pm daily, Monday through Friday, except holidays.
  - — Short-duration operations, including system startup and shutdown, will be concluded within a continuous ten hour period.
  - — Long-duration operations of at least 100 hours of continuous operation or more will be occasionally conducted.
  - — Normal operating capacity of feed preparation and support systems will be sufficient to support facility operations which are scheduled at least ten working days in advance.
  - — Operations with waste will be conducted within the bounds of treatability studies or other approved regulatory requirements.

4.7 Off-Normal Operation

Off-normal operation may be the result of degraded equipment performance, loss of required utility services (electrical power, compressed air, etc.), or malfunctions that affect system performance (safety functions excluded). During off-normal events, the affected components, the affected systems, or the entire MWMF will be safely shut down for corrective action as appropriate. A controlled restart of the affected system(s) may be executed after an off-normal event has been cleared.

4.8 Emergency Operation

Emergency conditions are off-normal conditions where loss of safety functions are involved. During emergency conditions, normal operations cease and equipment not performing a safety function is automatically (or passively) shut down. All MWMF systems will be designed to passively fail-to-safe without presenting a hazard to personnel or the environment. A controlled restart of the affected system(s) will be executed after an emergency condition has been cleared.

4.9 Future Operation

Future operations may be changed to accommodate changes in the MWMF configuration, including addition and/or removal of systems. Future operations may also be changed to allow multiple primary treatment systems to be operated or tested simultaneously on the same or different feeds.

5.0 Material and Operational Flow

The following sections summarize the functions of each operational area within the MWMF, and demonstrate the normal flow of material among the systems. Figure 5-1 shows the building B695 MWMF floor plan. Figure 5-2 shows the flow of materials through the MWMF, from receipt, through feed preparation and waste treatment, to the preparation of final forms. The major process support functions are also shown.

The MWMF will be integrated with LLNL's future Decontamination and Waste Treatment Facility (DWTF) complex. The DWTF will manage site-generated waste, which will be processed, stored, packaged, solidified, treated, or prepared for shipment and off-site disposal, recycling, or discharge to the sanitary sewer. The DWTF is operated by HWM.

5.1 Receiving

Receiving is a support operation that provides facilities for handling incoming materials needed for treatment demonstrations. This is a clean area where no waste containers are opened and, under normal operating conditions, no mixed, radioactive or hazardous material is directly handled. Receiving consists primarily of container-handling equipment and nonintrusive characterization equipment.

Receiving accepts containers of reagents and material used for surrogates from off-site vendors, and mixed waste from HWM. Receiving must be able to handle all the different types of reagent, surrogate material, and mixed waste containers entering the MWMF. Nonintrusive characterization is used to determine if waste meets the MWMF WAC, to determine proper routing based on waste composition, and identify, where possible, any hazards. After inspection, containers are prepared for handling by the feed preparation and transport systems and then staged prior to transfer into the process area. The MWMF will minimize staging of waste by requisitioning only that material needed for same-day processing by the feed preparation systems.

Container handling. As containers are received, they are stored awaiting inspection. Containers are individually inspected at the inspection station. If the container is accepted, it is labeled to permit tracking within the facility and, if necessary, it is repackaged into another container. It is then placed on a special pallet that provides secondary containment in the event of a spill and is assigned in-process storage locations by material compatibility code. When full, the pallet is put into the staging area. Pallets are moved from the staging area to Solids Feed Preparation (SFP) when requested. If a container is rejected it is returned to HWM with the next shipment.

Container inspection. The container inspection system provides information needed by the receiving area for all containers entering the facility. Visual inspection is performed to verify container integrity and correct markings. The container identity is checked to enable retrieval of information from the original waste requisition. The

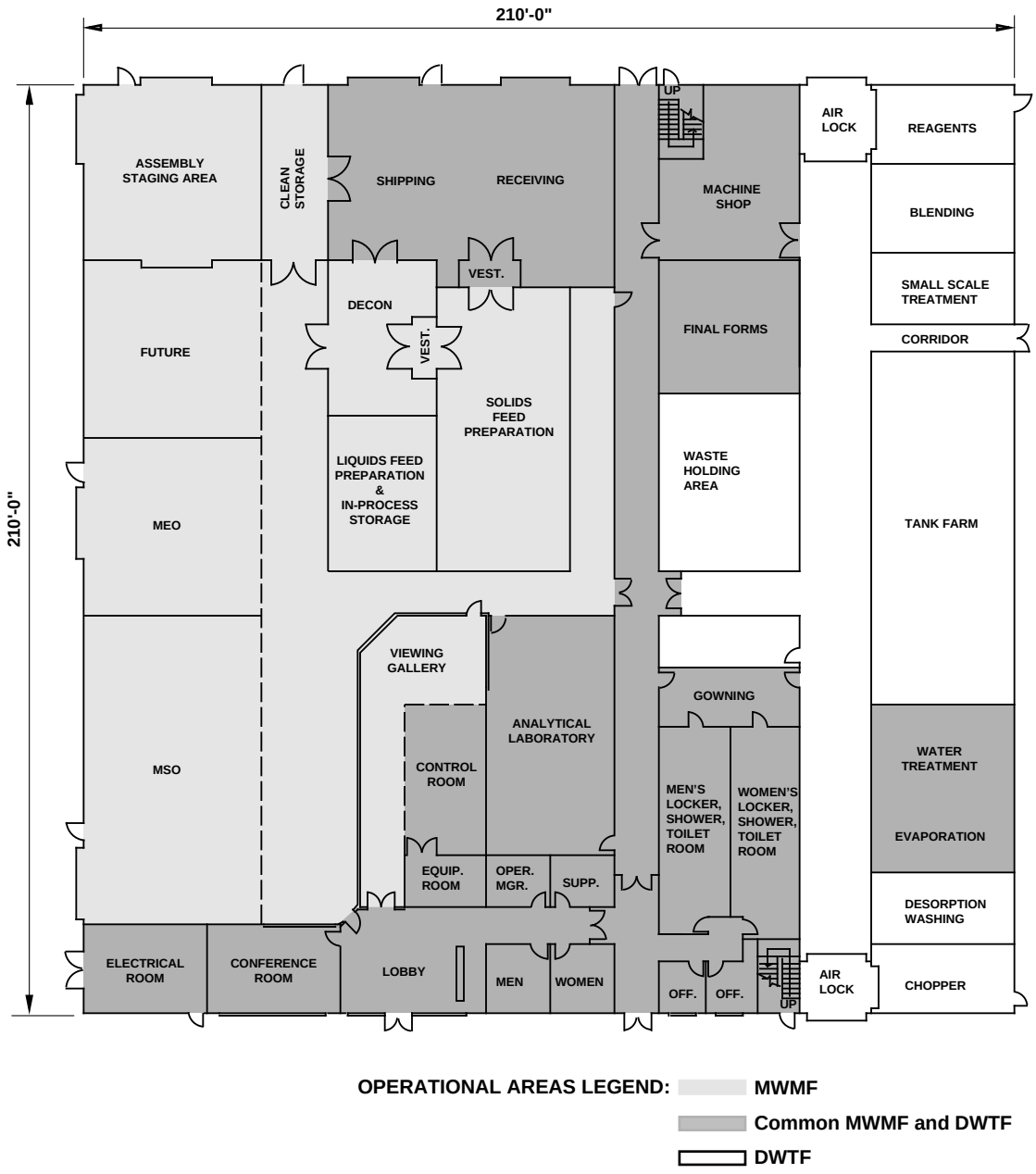

Figure 5-1. Building 695 MWMF floor plan.

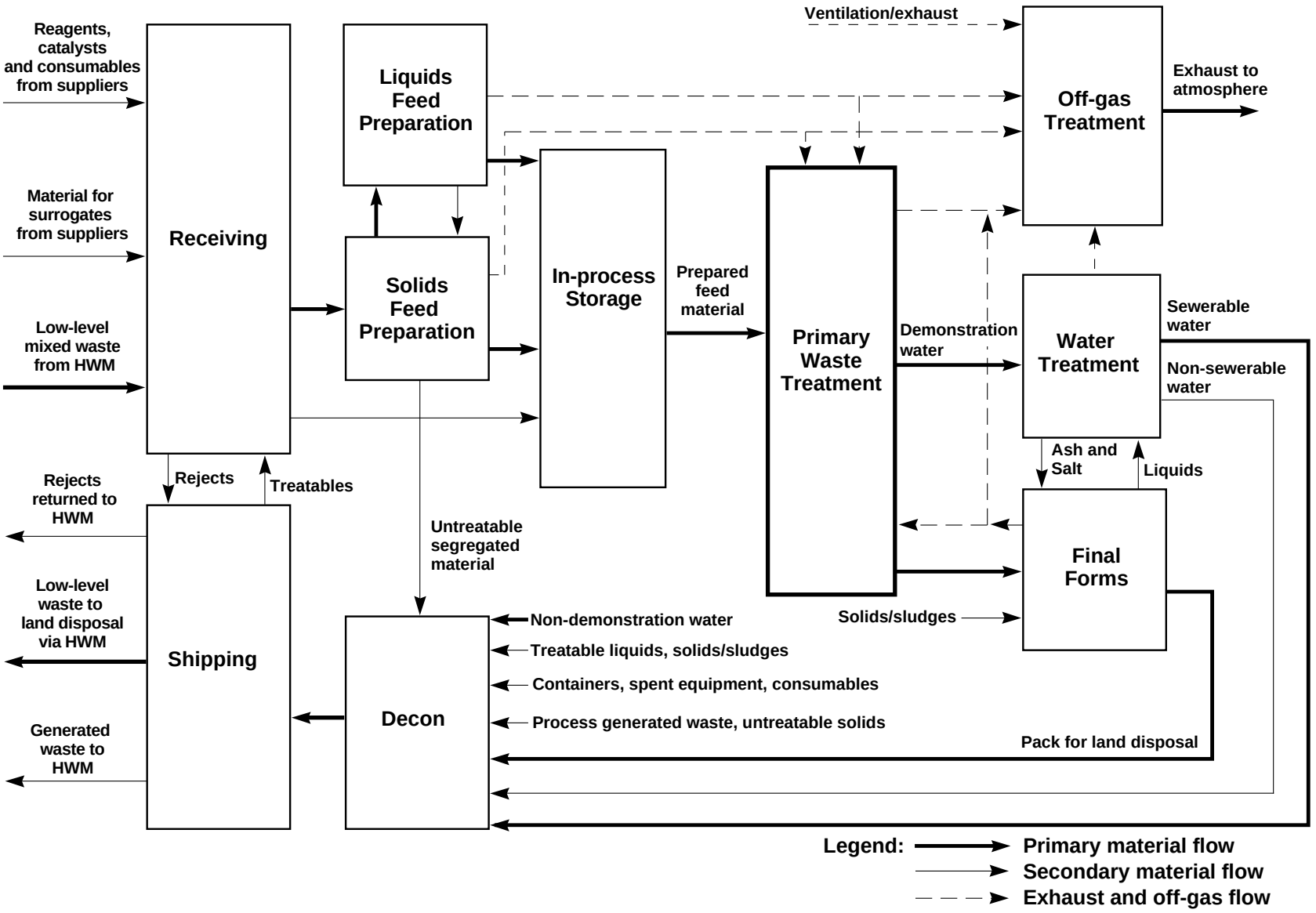

Figure 5-2. Simplified MWMF material and process flow diagram.

container weight is measured to ensure that it meets MWMF weight criteria, and a radiation scan is performed to verify the total surface dose is less than 200 mrem/h. Swipes of every container are scanned for radiation to verify that no removable surface contamination exists. For waste drums, videotaped radiograph images are examined to identify liquids within solid waste, items within the waste that could be a hazard, and the fraction of organic waste in the container.

Container preparation. For proper tracking, all containers will be uniquely identified using bar codes or similar tagging techniques. One- and five-gallon containers and boxes of scintillation cocktails are placed in special containers so that they can be tracked using standard equipment and so that transporting them into the facility can be easier, more efficient, and safer. All containers are then placed on a standard secondary containment pallet that securely holds all the different types of containers in place and acts as secondary containment in case of container leaks. If necessary, standard container lid clamps are replaced with ones that are more easily removed remotely.

5.2 Solids Feed Preparation (SFP)

SFP is a support system that processes incoming waste and surrogate material in preparation for treatment by the MWMF primary treatment processes. SFP includes processing equipment and instrumentation for receipt, characterization, handling, and processing of homogeneous and heterogeneous organic solids. The incoming waste stream is segregated into organic solids, heterogeneous solids, homogeneous inorganic solids and metals, and containerized liquids. The segregated streams are processed as follows:

- Organic solids are processed as required to form the solid organic feed for the treatment processes.
- Heterogeneous solids, with appreciable organic content, are processed to separate the organic portions from the inorganic portions.
- Inorganic solids and metals are not prepared for treatment, but are repackaged for return to HWM.
- Containerized liquids are transferred to the Liquids Feed Preparation (LFP) area for processing.

All incoming waste containers flow through SFP to provide for container venting, sampling and opening. Outgoing empty containers are processed through decontamination.

Receiving and unloading. For contamination control, a vestibule provides the interface between the ambient pressure zone in the receiving area and the lower-pressure zone in SFP. The receiving and unloading system accepts material from receiving on secondary containment pallets, confirms their identity, and transports them to the appropriate feed preparation station.

Data collected from the secondary containment pallet and individual containers are compared with on-line computer tracking information to confirm container identity and to log the waste into the SFP waste-tracking system. Containers not matching the manifest are returned to shipping (via decontamination) as rejects. Containers are moved through the vestibule and into the extraction station. Container hold-downs are removed, and the drums are transported to the drum accumulation station.

The accumulation station provides an input queue for containers awaiting opening, venting, and sampling and allows manual access for handling and preparing small containers prior to processing. The system includes container transport equipment, a drum transfer station, and an enclosure to handle containerized liquids such as boxed scintillation-cocktail vials and carboys. Vials are removed from cardboard boxes and placed in a device that is used to feed the vials into the hopper of the vial-emptying equipment. Carboys are transferred to the appropriate station in the LFP area for processing. Liquid drums and overpacks are transferred via the conveyor system to the LFP area. The containers of solid waste are transferred to the drum opening and vent station.

The drum opening and vent station receives primarily drums containing solid waste (although other containers can be handled as required) and provides the capability for cover gas sampling and venting to prevent potentially hazardous or flammable gases from escaping into the local environment. The drums are opened in an enclosure with the gases being swept into the exhaust system, and the opened drum is moved via the internal drum transport system to the drum dump station.

The drum dump station receives open drums and provides for controlled dumping of the contents. The system consists of a drum dumper, screener / feeder and catch tray. The screener / feeder is equipped with the capability to separate the expected packaging material (i.e., diatomaceous earth and vermiculite) from the solid-waste items. Free liquids are captured in a tray beneath the screener / feeder for collection and packaging prior to being sent to LFP for processing. The screener / feeder transfers the solid waste items to the primary sort tray. Down draft venting at the screener / feeder controls and minimizes potential contamination in the room.

Item characterization and preliminary sort. Preliminary waste sorting segregates the waste stream based on obvious and easily measurable physical characteristics such as shape, size, color, texture, weight, and composition (i.e., paper, plastic, metal, wood).

Items dumped in the sort tray are radiologically surveyed to segregate for return particularly hot items that may have been shielded from external container scans by the waste container or contents. After segregation of hot items, obvious items in the primary sort tray are separated into organic solids, heterogeneous solids, homogeneous inorganic solids, metals, liquids not previously identified, and unknowns by an operator controlling the manipulator system, camera systems and the fluoroscope.

Organic solids (paper, cardboard, plastics) are collected and either placed in the in-process drum storage containers or sent to the definitive sorting station based on which organic stream is being processed. Heterogeneous solids and unknowns are sent on to the debag and sorting station, where they are examined with the fluoroscope and camera systems for identification. Homogeneous inorganic solids and metals are collected and packaged in new 55-gal drums, the waste source containers are recorded,

and the drums are moved to the decontamination area using the three-axis remotely operated crane. As containers of liquids are encountered, the source waste drums are recorded, and containers of compatible materials are collected in temporary accumulation drums. When an accumulation drum is full it is moved to LFP for processing.

Once the discrete items have been sorted, any free liquids that were present within the container are collected and packaged, the waste source containers are recorded, and the drums are moved to LFP. Packaging materials such as diatomaceous earth and vermiculite are also collected, packaged, the waste source container is recorded, and the container is moved to the decontamination area.

Definitive sorting. Definitive sorting removes items from their packaging materials (predominantly bags) and segregates undesirable items from the stream in preparation for processing. For example, a stream containing predominantly wood and paper may also have metal and glass items that are more easily removed from the stream prior to shredding.

Containers and items other than drums are transported to the debag-and-sort station, where the boxes, cartons, small drums, cans, etc. are opened and visually inspected and their identification confirmed. The plastic bags enclosing items are then removed, and items not agreeing with the manifest are evaluated as to their acceptability for processing. Rejects are packaged and sent to the decontamination area for return to HWM. Acceptable items are placed in their respective in-process storage drum or continue to the size-reduction station.

Heterogeneous solids and unknown materials are separated into individual items, then characterized and sorted into mostly organic solids, inorganic solids, and metals. Characterization is accomplished by reducing items into smaller parts of like composition using operator judgment, the fluoroscope, metal detector, and size-reduction tools. For example, a screwdriver with an organic handle could be separated into the metal shaft of the screw driver and the organic handle, and the parts processed accordingly. The metal shaft would be packaged and sent to decontamination while the organic handle would continue through treatment.

Physical conditioning. Physical conditioning converts waste items into a physical form and composition suitable for treatment in the primary processes.

The size-reduction equipment accepts primarily homogeneous organics and reduces the particle size, as necessary, for feed to the treatment processes. Size reduction will also accept heterogeneous and unknown solids and reduce the items to a smaller size to facilitate more exact characterization and sorting. In the initial phase of operation this equipment includes shredders, pulverizers and screens. This equipment is capable of reducing, in a uniform manner, all expected initial organic waste stream items to particle sizes ranging from 25 cm down to 3 mm.

Magnetic and paramagnetic separators are used to remove gross metal constituents that may adversely affect the treatment processes. These metals are characterized to the extent practical, packaged, labeled and sent to decontamination. The remaining, primarily organic, material is characterized and segregated into various lots for the treatment process feed. Initially these ranges consist of three groups. The first is

materials of high mineral content and low thermal value; the second of moderate mineral content and moderate thermal value; and the third low mineral content and high thermal value.

Organic solids are then stored in specific hoppers based upon their composition. These hoppers are part of the blend station, where specific blends based upon treatment process requirements are made upon request. The organic solids are blended with organic liquids from the LFP system, sampled, and then sent to the treatment processes as required. The capability to pelletize the blended mix is also provided for those processes requiring a pelletized feed.

Repackaging. Repackaging collects reject materials from within the SFP area and characterizes and stores them in designated 55-gal drums for return to HWM. Storage drum designations are by material type (e.g., ferrous metals, nonferrous metals, inorganics, and predominately metal). Each reject item's identity is collected and maintained along with the identity of the source waste drum from which it came. When full, drums are labeled, a temporary lid is attached, and they are transferred to the decontamination area. Lids are also installed on empty containers prior to transfer to decontamination.

5.3 Liquids Feed Preparation (LFP)

LFP processes incoming material to prepare liquid wastes and surrogates for treatment by the MWMF primary treatment processes. The liquids are received from SFP in containers. Their contents are organic and organic/aqueous liquids, and may also contain solids and sludges.

LFP includes processing equipment and instrumentation for the receipt, characterization, preparation for processing, and handling of homogeneous and heterogeneous liquids. These provide for the identification and segregation of the input material stream into appropriate categories for treatment and conditioning of the material to meet treatment process requirements. Operations are performed in enclosures to minimize the spread of volatile, hazardous, and radioactive materials during processing.

Receiving and Sampling. The receiving and sampling system accepts containers of material from SFP, confirms their identity, and transports them to the appropriate station. Data collected from individual containers are compared with on-line computer tracking information to confirm container identity and to log the waste into the LFP waste-tracking system. Containers not matching the manifest are returned to SFP as rejected containers. Accepted containers are sampled, as necessary, to confirm or identify contents and allow segregation for further processing.

Container Emptying and Liquid/Solid Separation. After container contents are confirmed, the containers are opened and emptied and the liquid or liquid/solid contents are transferred to the appropriate holding tank. Tanks are assigned to allow sorting of the incoming waste stream into organic liquid and aqueous feed stocks.

During the transfer process, entrained solids / sludges are removed prior to the liquids entering the holding tanks. Wet solids / sludges and containers are returned to SFP.

Liquid/Liquid Separation. Emulsions, like Trimsol™, are then processed to separate the aqueous and organic material when requested by the primary treatment process. The resulting streams are fed to in-process storage tanks to accumulate enough material to prepare a batch of feed for treatment. Treatable water is transported to Water Treatment (WT).

Storage/Blending. Prepared material is held in in-process storage until requisitioned by a primary waste-treatment process technology. The organic liquids are blended, if required, and sampled prior to transfer out of LFP. Feed requested as a liquid is sent via Process Transport and Storage (PT&S) to the treatment process requesting the feed. Feed requested as a slurry is transferred to SFP, where it is mixed with solid material, sampled and delivered to the treatment process.

5.4 Process Transport and Storage (PT&S)

PT&S provides transport and in-process storage of waste, surrogate feed materials, and samples at rates meeting Feed Preparation, Waste Treatment, and Analytical Services needs. Materials are tracked to maintain chain-of-custody information. The PT&S system provides equipment for the collection, transfer, and deposit of containers, discrete items, dry and wet bulk materials, slurries, and liquids as required for facility operations, and instrumentation required for material tracking and to support the local monitoring of storage and transfer operations.

Receiving and Identification. Containers requested to be moved are checked to verify the identity of the container, the container integrity, and that exterior surfaces are free of contamination. If everything is in order, the container is accepted and entered into the PT&S material tracking system.

Material Conveyance. Accepted items are moved to designated drop-off locations at the treatment processes or to interim storage and their locations logged in the material tracking system.

Storage. Material that must be stored prior to treatment (i.e., material awaiting analytical results) is placed in in-process storage in specified locations depending upon the container type, contents, and material compatibility code. Secondary containment and routine monitoring are provided for all stored material. Special utilities and environmental controls are provided depending upon the material and requirements (e.g., refrigeration of samples that need analysis for VOCs).

5.5 Primary Waste Treatment

The primary treatment processes receive appropriately characterized mixed-waste streams and convert the organic constituents of these materials into inorganic by-products. Primary process systems each remain in place until adequate operational and engineering data are obtained for performance assessment. After the demonstration cycle is completed, each primary process system will be evaluated for future needs. Those systems having no future mission will be decommissioned and removed from the MWMF, providing floor space for other process systems to be installed and demonstrated. Those systems having future mission(s) will be reviewed as appropriate.

At startup of the MWMF, the following primary process systems will be installed and activated for demonstration: (1) Mediated Electrochemical Oxidation (MEO), which uses a low-temperature electrochemical cell to convert the organic constituent of mixed waste to carbon dioxide and water, and support systems for such functions as reconstituting the electrolyte, concentrating radioactive and other materials, and recovering the mediator; (2) Molten Salt Oxidation (MSO), which uses a thermal process to convert the organic constituent of mixed waste to carbon dioxide and water, removes residues containing the radioactive constituents, and recycles/processes the spent salt; and (3) Experimental Off-Gas (XOG), which demonstrates advanced off-gas treatment technologies that minimize secondary waste. The following sections summarize the material and operational flow for each of these primary treatment processes.

5.5.1 Mediated Electrochemical Oxidation (MEO)

MEO is an aqueous process that treats mixed waste by oxidizing the organic components into carbon dioxide and water. MEO is ideally suited for destroying aqueous organic liquids, organic liquids, and some organic solids (e.g., paper and other cellulosic materials) that can be pulped or slurried.

Materials that enter the MEO system principally include waste or surrogate feed, hydrogen peroxide, hydrochloric acid, sodium hydroxide, water, and nitric acid. Waste and surrogates are received in discrete batches and queued locally for continuous feed into the MEO unit. Other materials for maintaining electrolyte and pH balance are pumped from local storage tanks through permanent connections. Feed material is accepted from LFP, SFP, and in-process Storage as provided by PT&S. Organic liquids are accepted from LFP in containers for small volumes. Cellulosic solids (paper and cloth) are accepted from SFP in containers.

Some materials are recycled within the MEO system:

- Nitrous acid produced in the MEO cell is converted back to nitric acid in a gas/liquid contactor to minimize NO_X production.
- Silver chloride produced from destruction of halogenated waste is collected by centrifuge during the acid recovery process and integrated into batches. Each batch is passed into the Silver Recovery System within MEO, where it is recovered as silver nitrate for reuse in the MEO electrochemical cell.

- Process off-gases from the MEO system will be collected into three basic streams: (1) gases emerging from the anolyte, (2) gases emerging from the catholyte, and (3) general storage tank vents. All three MEO system off-gas streams will be chilled to 5°C to remove nitric acid and VOCs that have evaporated in the MEO process equipment. The chilled condensate will be collected in separate tanks for analysis, if desired, then returned to MEO.
- Spent anolyte is recycled in the MEO Acid Recovery System. The Acid Recovery System collects spent anolyte, removes silver chloride precipitate, performs primary evaporation with high solids content, removes water from the evaporated nitric acid in a fractionator, and stores the recovered nitric acid and water.

Materials that leave the MEO system include include gaseous reaction products, distilled and salt waters, mineral residues, and enclosure ventilation air. NO_X gases are treated locally and then piped with other gaseous products to be dried and passed to the Off-Gas System after samples are acquired for analysis by Analytical Services. Enclosure ventilation air is filtered and acid-scrubbed by the Off-Gas system. Distilled water from the Acid Recovery System and condensate from the off-gas drier are pumped into local storage tanks, which are transported to WT when full. Mineral and other inorganic solid products, as well as concentrated slurry residues, are transferred in containers to Final Forms for immobilization. Samples will be collected and given to Analytical Services for analysis.

5.5.2 Molten Salt Oxidation (MSO)

MSO is a thermal process that converts the organic constituent of mixed waste into carbon dioxide and water. MSO can treat a wide variety of solid, liquid, and gaseous material streams. Radionuclides, metals, and other inorganics, such as minerals and noble metals that may be in the material stream, are captured and held in the salt for subsequent separation and final processing. Acid gases such as chlorine, fluorine, and bromine are captured in the salt as chlorides, fluorides, and bromides, respectively. These will be removed from the salt when the salt is recycled.

Materials that enter the MSO system principally include waste or surrogate feed, replacement salt, oxidant air, and standby fuel. Waste and surrogates are received in discrete batches and queued locally for continuous feed into the MSO primary unit. Incoming waste or surrogate feed material is accepted from LFP, SFP, and in-process Storage as provided by PT&S. PT&S tanks will have a direct interface with the injector feed tanks on the Primary Unit. Organic liquids and cellulosic solids (paper and cloth) are delivered to MSO in containers. Compressed air is piped in for operating valves, providing back pressure to feed systems, and for oxidant air in the MSO process. Makeup salt is stored locally.

Some materials are recycled within the MSO system:

- Spent salt is recovered in the Salt Recycle subsystem. Metals, radionuclides, minerals, and sodium halides are separated from the salt. Recovered salt can be reused in the MSO primary unit.

- HEPA filters are part of the Off-Gas System. As these HEPAs become clogged, they will be cycled through the MWMF to SFP. SFP will size-reduce the HEPAs and prepare them as feed for the MSO unit.
- Coolant air for the MSO vessel is a closed-loop ducted system that interfaces with a heat exchanger fed by facility-supplied chilled water.

Materials that leave the MSO system include include gaseous reaction products, condensate, brine, mineral residues, filter cake, and enclosure ventilation air. The Process Off-Gas System removes entrained salt from the gaseous products. The gaseous products are then dried and piped to the Facility Off-Gas System after samples are acquired for analysis by Analytical Services. Enclosure ventilation air is filtered and acid-scrubbed by the facility Off-Gas system. Brine from the Salt recycle system and water condensate from the local off-gas are pumped into local tanks, and subsequently transferred to WT. Mineral residue filtrates and other inorganic solid products produced in the Salt Recycle subsystem are transferred in containers to Final Forms for immobilization. Samples will be collected and given to Analytical Services.

5.5.3 Experimental Off-Gas (XOG)

XOG treatment removes hazardous components from gaseous effluent of mixed-waste treatment processes. The objective of the XOG treatment system is to demonstrate advanced, innovative technologies that minimize secondary waste. Two technologies destroy NO_X and one demonstrates state-of-the-art methods for removing particulates from the process off-gas. Selective Catalytic Reduction (SCR) selectively reduces NO_X to nitrogen and water by adding ammonia to an oxygen-containing exhaust stream that passes over a catalyst. Advanced Wet Scrubbing of NO_X with Acidic Urea is accomplished using a gas/liquid contactor. Advanced Metal Filters are high-efficiency steel filters that can be cleaned in-situ by reverse air pulses.

XOG technologies accept piped process off-gas from other primary waste treatment systems and from process support systems. Containerized reagents and equipment enter the XOG system via PT&S.

Process residuals include treated off-gases, which are ducted to the Off-Gas Treatment (OGT) system where they are acid scrubbed and HEPA filtered. Dust collected on XOG filters is transferred in containers to Final Forms for immobilization. Reusable HEPA filter elements are cleaned and returned to service. Consumable filter elements are transferred to Decontamination (Decon) or Final Forms in reusable containers for disposition as appropriate. Spent SCR catalysts are sent to Decon for disposition, packaging, and shipping, as appropriate.

5.6 Final Forms

Final Forms provides the process technology for immobilization of mixed waste inorganic residuals. The residues are generically grouped as minerals and salt. These are immobilized respectively as ceramic and polymeric waste forms that are designed to

be acceptable for disposal as low-level radioactive material in approved DOE disposal sites. *Mineral* residue refers to the principal residues remaining after organic components of the material have been oxidized by the primary processes and includes oxides, nitrates, and free metals. *Salt* is sodium chloride (and sodium fluoride in lesser amounts) resulting from the treatment of halogenated organics. In addition to these, a small quantity of volatile inorganic compounds are vaporized and trapped in the off-gas systems of primary and support processes. These are not immobilized by Final Forms but are collected by the generator process and sent to HWM for disposal.

Final Forms accepts residuals from the primary treatment processes and WT as solid waste forms in containerized batches, and spent process filters in reusable containers. The residues are received as powder, as dry or moist filter cake, and as concentrated slurries (with some of the residues in solution). Secondary waste streams from the primary processes (such as from cleaning vessels) may also be included.

Final Forms process residuals include process gases, process water, final form low-level material suitable for land disposal, and enclosure ventilation air. Process gases are contained and piped to the OGT system. Process water is transferred to WT in containers, sometimes after preliminary filtration. Final forms low-level waste is transferred to Decon for release to HWM via Shipping. Enclosure ventilation air is filtered and acid scrubbed by OGT. Discarded materials, process generated wastes, and materials that fail process acceptance criteria are collected, packaged, and sent to Decon for disposal via Shipping as appropriate.

5.7 Decontamination (Decon)

The decontamination system provides the capability to clean and inspect containers and equipment prior to transfer to shipping or refurbishment. Equipment in the decontamination area includes a five-ton overhead crane, a decontamination enclosure, a liquid-medium cleaning system, a radiation-detection system, cameras, and miscellaneous hand tools. Drums from SFP are decontaminated in this area using a liquid-medium cleaning system. This cleaning system is composed of a liquid carbon dioxide system capable of producing either pellets or snow for cleaning all surfaces of empty waste drums and the outside of drums containing reject materials going back to HWM. The liquid carbon dioxide system is backed up by the pressurized-water decontamination system.

Temporary lids are removed from drums as they are prepared for decontamination. The rim is cleaned, and a permanent lid is installed on full drums of reject material. Temporary lids are reinstalled on empty drums. The remainder of the drum is then decontaminated, and the surfaces are scanned to verify that the radiation dose at the surface does not exceed 200 mrem/h. A swipe scan is then conducted to verify that there is no removable contamination on exterior surfaces.

5.8 Shipping

Shipping is a support operation that provides facilities for handling outgoing materials generated by waste-treatment process operations. This is a clean system where no waste containers are opened and, under normal operating conditions, no mixed, radioactive or hazardous material is directly handled. Thus, shipping consists primarily of container-handling equipment.

Shipping accepts containers holding mixed and hazardous waste generated within the facility, inspects them, and prepares them for shipment to HWM. They are then held for pickup by HWM.

Waste containers removed from Decon are placed in the shipping in-process storage area. From there, they are moved to the inspection station, where they are weighed, swiped, and scanned for radioactivity and, if found acceptable, put on a pallet for shipment to HWM. All containers are properly marked for shipment, and a requisition for each container is generated and attached to the drum. Drums are banded on pallets provided with secondary containment as required and held for pickup by HWM.

5.9 Water Treatment (WT)

WT receives aqueous streams with demonstration interest from PT&S in portable containers. Aqueous streams from waste processing systems may be part of a Treatment Train demonstration and thus have demonstration interest, while other aqueous streams may not. The major function of WT is to be an integral part of the waste treatment train being demonstrated by completing the aqueous treatment to environmentally acceptable standards as selected by the objectives of the demonstration. WT continues treatment on some streams and prepares solids from others. Water without demonstration interest will be forwarded by PT&S directly to HWM for disposal. The major products of WT include engineering test data from WT's portion of waste Treatment Train demonstrations, mineral and salt solid products that are acceptable to the MWMF Final Forms system, and treated water destined to HWM for sewering.

Materials such as reagents, clean containers, organic adsorption materials, and filters are delivered by PT&S from the clean storage area.

WT maintains segregation of incoming waste streams by source and campaign in portable containers, treats and analyzes them, and then transfers them in portable containers to HWM. HWM manages all sewer releases.

Materials that leave WT include treated water that meets the demonstration objective (generally meets or exceeds LLNL sewer requirements), spent organic adsorption materials, spent containers, gases displaced from liquid containers, and solid residuals. Treated water not meeting LLNL sewer requirements is either retreated or transferred to HWM. Mineral and salt solid residuals that meet Final Forms PAC are containerized and transferred to PT&S for transfer to Final Forms. Those solids that are not acceptable to Final Forms are packaged and sent to HWM. In addition, small quantities of aqueous material that are not of demonstration interest are produced in the MWMF. These are containerized and transferred to HWM by PT&S.

Spent containers, drums, and unused reagents are transferred by PT&S to Decon for disposition as appropriate. Spent organic adsorption material is transferred to Decon in

reusable containers for disposition as appropriate. Spent filter elements are transferred to Decon or Final Forms in reusable containers for disposition as appropriate. Displaced fluid container air, vapor and other off-gases are contained and piped to OGT.

5.10 Off-Gas Treatment (OGT)

OGT is provided to remove hazardous components from gaseous effluent generated in primary and secondary processes. Process OGT protects process equipment and personnel servicing that equipment from contamination. Depending on the source, process OGT either reduces NO_X or removes CO and VOCs. BACT processes are employed in both cases, and caustic scrubbing is provided for acid gases formed by the oxidation of halogenated VOCs.

Treated process off-gas, ducted enclosure gas (typically air), and room air are exhausted to the atmosphere via the Facility Off-Gas HEPA filter system. A backup charcoal adsorption unit protects against sudden rises of VOC concentration in the facility exhaust caused by spills in areas such as SFP, where VOC concentration normally is below the treatment level.

OGT accepts piped or ducted process off-gas from primary waste treatment systems and from process support systems. Containerized reagents are delivered to the OGT system by PT&S.

OGT residuals include treated and filtered off-gas, spent catalysts, filters, charcoal, dust, and other process consumables. Treated off-gas is released to the atmosphere through the facility exhaust stack. All other residuals are sent to Decon for release to HWM via Shipping, or for processing by SFP and subsequent consumption by the waste treatment processes.

5.11 Analytical Services

Analytical Services provides chemical and physical measurement and analysis capabilities to the MWMF. It also provides on-line monitoring of gaseous species as required to meet air permitting requirements. Calibration of on-line sensors is provided to support the various processes.

Analytical Services is equipped to perform basic radiochemical, organic, and inorganic screening as required for daily operation of the facility. Additional analytical resources are leveraged by using other LLNL on-site services, and commercial resources as required. Analyses performed within the MWMF are those that (1) are integral to daily operation of the facility, including at-line measurements required for process characterization, control, or development, and measurements for rapid identification of organic and inorganic unknowns, and (2) are required for sample shipment to other on- and off-site analytical laboratories (primarily radiation screening). Analytical Services also provides ancillary systems to store, track, and report measurements on a variety of discrete samples.

Material samples are accepted from each of the feed preparation, waste treatment and process support systems in containers typically less than 500 mL in volume.

Reagent and chemical standards are accepted from Receiving as received from the supplier, typically in ampoules. Containerized process reagents, catalysts, etc. are requested and accepted from in-process Storage for quality sampling as required by the waste treatment and process support systems.

Materials that leave Analytical Services include process-generated aqueous and organic hazardous waste, aqueous and organic mixed waste, waste scintillation cocktails, contaminated glassware, and laboratory solid waste. Other process residuals include material samples, sink water, and fume hood ventilation and instrument off-gas exhausts.

Hazardous wastes and contaminated glassware are transferred to Decon for release to HWM via Shipping. Mixed wastes, scintillation cocktails, and laboratory solid wastes are transferred to Decon for routing through Shipping for HWM acceptance. Acceptable material then reenters Receiving and is transfered to SFP. Each of these is transferred in five-gal carboys except for contaminated glassware and laboratory solid waste, which are transferred in overpacks.

Material samples are transferred to Shipping via Decon for transportation to LLNL's on-site and off-site analytical laboratories. Samples going to off-site laboratories are processed through LLNL's Materials Management Division. Transfers are made in ice chests maintained at 4°C. Fume hood ventilation and instrument off-gas exhausts are contained and ducted to the OGT.

5.12 Instrumentation and Control (I&C)

The MWMF I&C system is a computer-based, real-time–distributed process-control system. It provides integrated control and monitoring functions, from the interface with the instrumentation and field devices that are installed in the preparation, treatment, and process-support systems, to the highest layer of MWMF information management. The system architecture forms an overall operational and technical information and control system to provide for efficient and safe startup, operation, maintenance and shutdown of the processes. The information elements of the control system provide the necessary data for normal operation and early detection of off-normal, unsafe, and emergency operating conditions.

Individual local process I&C systems are provided for all Feed Preparation Systems, Waste Processing Systems, and Process Support Systems. Each system is independently and autonomously operable, and provides facility operators the unique functionality required for detailed monitoring and control of the associated process. Local process I&C systems include sensors and actuators, a process control system, a process safety system, and a process workcell control system.

Supervisory I&C systems provide the integration elements and shared resources for the fully functional integrated facility. Supervisory I&C includes a Supervisory Control System, a Facility Database Management System, a Safety Control System, an Intercom System, a Closed Circuit TV System, and a Central Control Facility.

Collectively, the local process I&C systems and supervisory I&C systems allow the demonstration, testing, and evaluation of mixed waste destruction technologies in a safe, environmentally acceptable, reliable, and cost-effective manner. The I&C systems

provide fully integrated process monitoring and control; safety monitoring and control; data presentation; alarm processing; data logging, archiving and retrieval; access control; analysis; report generation; inventory control; and production planning.

Local Process Instrumentation and Control Systems. Instrumentation and control (I&C) systems are provided to manage efficient and safe startup, operation, shutdown, and maintenance of the Feed Preparation, Waste Processing, and Process Support processes. The I&C systems are independently and autonomously operable, and interact with the MWMF supervisory I&C systems and other process I&C systems where necessary.

Control and monitoring of treatment and support processes are accomplished by sensors, actuators, and instruments. Sensors measure process variables; actuators perform actions on the processes. More sophisticated instrumentation is used where simple sensors and actuators are insufficient.

Process safety systems are designed to protect personnel and the environment from hazards that may exist for the processes. In addition, high-value equipment is also protected. Safety systems operate independently from the process control systems. A process safety system allows the respective process to be operated only when all requirements for safe operation are met.

Process control systems acquire data from sensors and instrumentation, process the data, and provide real-time closed-loop control to actuators. They also provide general process interlocks and perform low-level sequencing of process tasks. Local alarm annunciation of off-normal events is accomplished through an alarm panel that displays alarm condition and indicates proper operator response.

Workcell control systems provide the primary operator-machine interface for each process through computer workstation technology. With appropriate input from an operator, a workcell controller coordinates and manages each process. Each workcell controller is configured to start, run, stop, schedule, and direct the activities of a local process. Each workcell controller operates independently, while at the same time communicating with the supervisory system for facility directives and with other cell controllers for coordination of inter-process activities. Workcell controllers are accompanied by additional computer terminals when additional graphical operator-machine interfaces are required.

Supervisory Control System. Integrated control of all process operations is provided by a supervisory control system accessed from the central control room. Operations data, key process performance parameters, and alarms are available at this location so that the operations staff can respond to normal operation functions and quickly and accurately identify off-normal conditions.

A operator-machine interface for facility-wide process monitoring, alarm processing, and data trending along with a fully functional operator interface are provided for each process. Workcell coordination is provided to manage inter-process activities among the local processes where necessary, and arbitrate resource conflicts between workcells.

The operational status of the facility's communications networks and processors is constantly monitored. Operators are notified of non-operational components so that appropriate corrective action can be taken. A facility monitoring system provides for

the monitoring of sensors and equipment associated with maintaining the proper operation of the facility.

Facility Database Management System. The facility database management system provides the procedures and tools for managing and manipulating the historical data gathered throughout the facility. It manages data acquired by the various process systems in support of process analysis, inventory tracking, and material accounting.

Process analysis is performed to examine both current operational performance and archived comparisons between processes for overall efficiency, process effectiveness, and quality control. The Inventory Tracking subsystem provides the current location of all containers in the facility that contain surrogate materials, waste, processing reagents, or process residuals. The Material Accounting subsystem maintains the chain of custody for waste, processing reagents, and residuals to verify permit compliance for the facility.

In addition to collecting and managing process data, operator-entered facility data and off-site data are also recorded and managed.

Facility Safety Control System. MWMF safety systems protect personnel and the environment from hazards that could exist in the facility. The Facility Safety Control System monitors conditions global to the facility, coordinates safety functions among the individual process safety systems where necessary, provides alarms necessary to alert personnel, and automatically returns affected systems to a safe operational state. The Facility Safety Control System operates independent from all other systems and allows the processes to be operated only when all requirements for safe operation are met.

Intercom System. A facility-wide personnel communications system is provided to facilitate checkout, operation, and maintenance of all systems and equipment.

Closed Circuit TV System. A system of surveillance closed circuit TV (CCTV) is provided to view all process systems and some support systems/areas from at least one vantage point, and each robot workcell from multiple vantage points. Operators in the control room and other control locations are able to monitor selected views of interest.

Central Control Facility. Central control facilities include a control room and an equipment room. The control room provides a centralized operations center for integrated process control, monitoring and alarming, analysis and reporting, material tracking, and robotic teleoperational control. The equipment room provides a location for electronic equipment that is not environmentally suited for placement in the control room for reasons of heat, acoustic noise, safety, or aesthetics.

6.0 Responsibilities and Authorities

ES&H implementation is a line management responsibility. A clear chain of ES&H responsibility and accountability extends from the Laboratory Director to all operating staff. Figure 6-1 shows this chain for ES&H management for the MWMF (delineated by the bold line). The Associate Director for Environmental Programs has been delegated ES&H responsibilities by the Laboratory Director (*LLNL Health & Safety Manual,* Chapter 1).[24]

In the MWMF, ES&H objectives are met through:

- Equipment—Design, deployment, testing, and maintenance of equipment is a controlled, orderly process as defined in the *MWMF Quality Assurance Plan.*[5]
- Methods and Procedures—Equipment is operated and activities are controlled through approved methods and procedures as will be defined in the MWMF Safety Analysis Report (SAR), the Facility Safety Procedure (FSP), supporting operational safety procedures (OSPs), permits and related documents.
- Trained Personnel—People working in the MWMF are trained in the safe and efficient operation of the equipment and are knowledgeable of the associated hazards and the controls to avoid the hazards. The training requirements are defined in the *MWMF Personnel Training and Qualification Plan.*[25]

This chapter defines the delegation of ES&H responsibilities for implementation of this ES&H methodology from design, construction, and activation activities to facility operations.

6.1 Project Manager

The MWMF Project Manager is responsible for executing the design, construction, and activation of the project. The Project Manager's activities directed to facility operations include: establishing and implementing an effective ES&H program for the project, including activation and startup operations; establishing design criteria for equipment and managing procurement, fabrication, assembly, installation, acceptance and startup; implementing and maintaining a QAP that complies with DOE Order 5700.6C; and obtaining the necessary permits required to operate the facility. The Project Manager is the principal interface to LLNL and DOE management as relates to the MWMF project and operation.

6.2 Assurances Manager

The Assurances Manager is responsible for the preparation of an integrated ES&H plan to ensure that federal, state, and local regulations are satisfied, for coordinating the NEPA and CEQA processes, and for assuring that all needed permits are obtained. The Assurances Manager also coordinates the hazards categorization and the safety analysis documents, ensures that applicable safeguards and security requirements are met, coordinates ORA activities, and performs assessments to ensure that requirements are

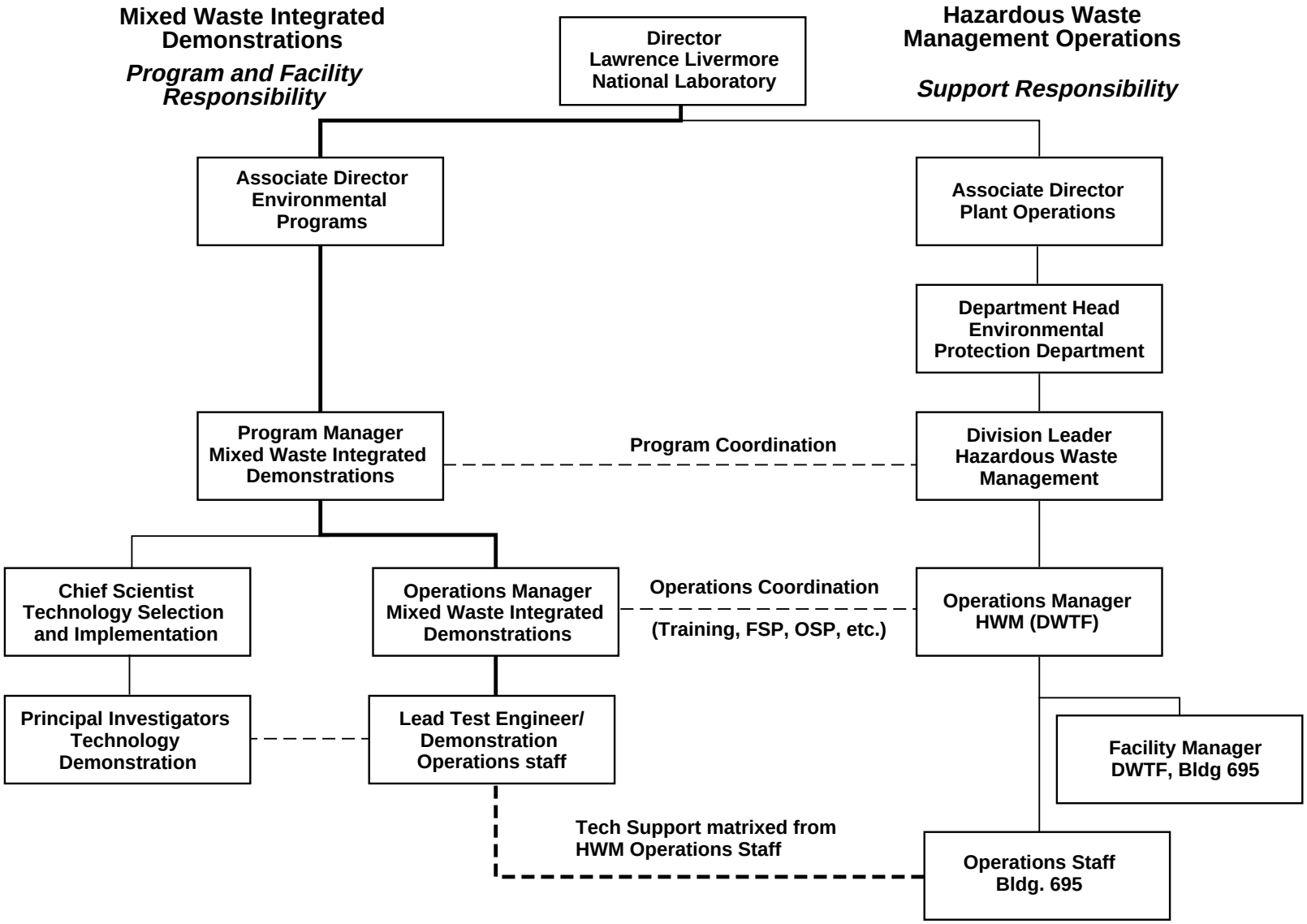

Figure 6-1. Draft Mixed Waste Management Facility Functional Organization (Initial Operations to DWTF Complex Activation and Operations).

met. The ES&H Team Leader reports to the Assurances Manager for project activities.

6.3 Quality Assurance Manager

The Quality Assurance (QA) Manager reports to the Project Manager. The QA Manager is responsible for maintaining the QA plan and program, conducting periodic monitoring activities to verify that the requirements of the QA plan are being met, providing assistance to program personnel in the implementation of the QA program, assisting in identifying and resolving quality issues, performing quality control activities, and establishing and maintaining a project QA records system.

6.4 Environment, Safety and Health (ES&H) Team Leader

The Environment, Safety and Health (ES&H) Team Leader is responsible for directing and managing an ES&H team which supports MWMF Project Management in its efforts to identify and resolve ES&H issues. The ES&H Team Leader is responsible to:

- Plan, organize, and coordinate the efforts of all team members to ensure an organized, unified approach to ES&H activities.
- Supervise and direct the activities of the Hazards Control members of the team.
- Monitor and direct ES&H support to ensure consistency with current standards and LLNL policy.
- Ensure effective communication between Team members, the Hazards Control and Environmental Protection Departments, and Project Management.
- Review and approve written correspondence from all ES&H Team members.
- Review and assist in the production of ES&H related documents such as Operational Safety Procedures, Facility Safety Procedures, and Safety Analysis Reports.
- Assist programs with self assessment activities, DOE audits and appraisals, internal appraisals, and self-help activities.
- Manage the ES&H Team overhead and direct budgets.
- Participate in and make final the selection of team members.
- Create and maintain a cooperative working relationship between the Teams and with the Technical Support and Policy Development Division.

6.5 Project Engineer

Project Engineers have technical performance responsibility to manage all design and construction efforts under their cognizance. This includes responsibilities for technical scope, quality, ES&H, cost, and schedule. Project Engineers are responsible for monitoring and reviewing engineering activities to ensure adequate technical requirements are established and met, scheduling and holding design reviews for key systems, and tracking and closing out design review action items. Project Engineers

institute configuration control procedures, carry out procurement control activities, and plan and carry out appropriate inspections and tests of facility and process equipment. They plan, specify, and monitor equipment fabrication activities, ensure non-conforming items are identified, tracked, and dispositioned appropriately, and ensure that the necessary QA records are generated and archived.

Project Engineers are responsible for all design commitments and for reporting any variances for resolution to the Project Manager. They interface with other project organizational elements and provide technical consultation and coordination to meet the project goals.

6.6 Lead Engineer

Lead Engineers have technical responsibility to specify, design, construct and activate systems to implement process technology. Within the bounds of that technology, Lead Engineers establish and maintain engineering drawings, sketches, engineering and safety notes, specifications, and other design documentation; verify and approve all fabrication drawings and specifications, track procurement and QA deliverables, and oversee construction and installation; and approve operations procedures and engineering notes, and training and coordinating operations personnel. The Lead Engineers are accountable for performance of the engineering design and cognizance of all health, safety, and environmental compliance requirements. They conduct preliminary and final design reviews, and resolve and document design review action items.

In conjunction with the Principal Investigator, the Lead Engineer is also responsible for developing an operating plan, for executing safe and effective operation, and for conducting the startup activation operations and facility operations.

6.7 Operations Manager

The Operations Manager manages MWMF staff and supporting functions for the operation of MWMF after Project completion, e.g., activation of process demonstrations. At such time the Operations Manager will be generally responsible to the line management of LLNL for the safe, compliant, and effective operation of the MWMF. Specific responsibilities, implemented through operations support personnel, include all operations within the MWMF, work scheduling, resource planning and control, staffing, operational interfaces both within and external to the MWMF, test and operational procedures, personnel training, documentation and records, compliance reporting, equipment maintenance and/or changes, and QA activities.

6.8 Operations Control Manager

The Operations Control Manager reports to the Operations Manager and is responsible for QA, financial, and administrative controls within the operational

MWMF. Responsibilities include assuring safety, environmental, and regulatory compliance; fiscal control and reporting; configuration control; documents and records; self-assessments; and other QA activities.

6.9 Principal Investigator

Principal Investigators provide the scientific direction of specific hazardous- or mixed-waste treatment technologies under evaluation within the MWMF. Responsibilities include the technical planning, direction, analyses, measurements, evaluation, and reporting for specific waste treatment technology. They participate in the operation of the assigned system, but are not necessarily qualified within this category for hands-on work with high-risk equipment or hands-on handling of hazardous wastes. These latter activities are accomplished through qualified operational staff.

6.10 System Operator

System Operators operate equipment or systems within the MWMF under the general supervision of the Operations Manager or his/her delegate.

6.11 Technician/Technologist Supervisor

Technician/Technologist Supervisors oversee the day-to-day activities of MWMF Operations Technicians/Technologists. Responsibilities include scheduling work and training activities, providing job-specific training and guidance, preparing job-related documentation and reports, conducting meetings on task scheduling and safety-related issues, ensuring work is performed safely, and other operationally related activities as directed by management.

6.12 Operations Technician/Technologist

Operations Technician/Technologists perform day-to-day hazardous- and mixed-waste handling activities. They operate hazardous- and mixed-waste treatment equipment (such as solidification and liquid waste treatment units), perform pre-receipt inspections of waste prior to transfer to hazardous-waste management facilities, receive waste at the hazardous-waste management facilities, segregate or bulk waste as necessary, package waste and place it into storage or prepare it for off-site shipment, and perform hazardous-waste management facility inspections.

MWMF Waste Technologists have experience in hazardous-waste management operations activities, either through employment at LLNL or elsewhere. They are able to work unsupervised, once they have demonstrated proficiency, through completion of

coursework and on-the-job training in LLNL hazardous-waste management operations and completion of the requisite coursework.

The MWMF Waste Technician is an entry-level position. For training purposes, waste technicians are assumed to have minimal knowledge of hazardous- and mixed-waste activities and regulations. They are closely supervised until they complete the required coursework and demonstrate proficiency in specific duties. They are then allowed to perform those duties with a lesser degree of supervision.

6.13 Facility Worker

Facility Workers perform general routine activities within the MWMF operational areas and require routine access to facility, but do not operate equipment or work with hazardous or mixed waste, or radioactive material. This category includes scientists and engineers responsible for general analytical, diagnostic, monitoring, design, maintenance, or similar support activities. All facility workers understand the general organization, hazards, and their controls, and other constraints involved in operating and being present in the MWMF. They are qualified to work on certain simple equipment specified by the Operations Manager, but are not to operate or to work on equipment of high risk or that involves processing of hazardous/mixed wastes.

6.14 Emergency Coordinator

The Emergency Coordinator coordinates all emergency responses for *large* incidents. The LLNL Fire Department Incident Commander fulfills the responsibilities of Emergency Coordinator as required by State and Federal regulations.

The Incident Commander has the authority to commit all LLNL resources and the capability to obtain outside resources needed to carry out contingency plans. The Incident Commander or his/her designee will:

- Assess the emergency conditions and initiate on-site response activities.
- Identify the character, source, amount, and extent of released material.
- Assess possible hazards to human health and the environment.
- Initiate evacuation of personnel as appropriate.
- Ensure that all required notifications to outside agencies take place.
- Notify appropriate state or local agencies with designated response roles if their help is needed (enlist support from agencies that participate in the Mutual Aid Agreement).
- Provide on-scene operational control for life safety, rescue, fire control and extinction, spill control and containment, and property conservation and salvage.
- Stop all waste-handling processes and operations in the area to prevent the occurrence, recurrence, and spread of fire, explosions, and waste releases.
- Ensure that monitoring is performed for leaks, pressure buildup, gas generation, or ruptures in valves, pipes, or other equipment.
- Ensure that recovered wastes, contaminated soil, or run-off water (from fire fighting, sprinkler systems, or broken water lines) are treated, stored, or disposed

of in accordance with all applicable regulations (may delegate this authority to HWM).
- Ensure that all emergency equipment is cleaned and stocked before operations are resumed (may delegate this authority to the MWMF Operations Manager).

6.15 Environmental Duty Officer (EDO)

The Environmental Duty Officer (EDO) is responsible for assisting the Incident Commander in making decisions regarding environmental issues. Designated LLNL Environmental Protection Department personnel, certified as EDOs, rotate the responsibility of EDO and remain on call 24 hours a day on a weekly basis. During off-hours, the EDO is the point of contact for environmental issues and has the option of calling in the Environmental Operations Group (EOG) Analyst for assistance.

During normal working hours, the EDO assists the EOG Analyst assigned to support the facility.

During off-hours, the EDO will assist the Incident Commander in making decisions regarding environmental issues. The EDO will:

- Identify the character, exact source, amount, and extent of released material.
- Assess the possible hazards to the environment.
- Ensure that waste that is incompatible with the released waste is not handled in the area of the release until cleanup is completed.

6.16 Environmental Operations Group (EOG) Analyst

The Environmental Operations Group (EOG) Analyst is the point contact for environmental issues during normal working hours. The EOG Analyst will notify the EDO when any incident occurs, and together they will assess the possible hazards to the environment. During off-hours, the Environmental Analyst may be called in to support the EDO.

7.0 Assurances

The ES&H Policy of LLNL is to take every reasonable precaution in the performance of work to protect the health and safety of both employees and members of the public, to prevent property damage, and to protect the environment. To implement this policy, LLNL has established, through line management, a comprehensive assurances program that requires the following:

- ES&H safeguards and operational procedures.
- Regulatory (Permitting) compliance.
- QA.
- Operations and safety training for facility staff.
- Periodic equipment calibration.
- Equipment preventative maintenance.
- Monitoring and inspection.
- Documentation.
- Self-assessment.

The key elements of these requirements are summarized below.

7.1 Environment, Safety and Health (ES&H)

LLNL's ES&H policy is that operations will be planned and performed safely, with full consideration for the protection of employees, the public, and the environment. In addition to observing LLNL policies contained in the *LLNL Health & Safety Manual*[24] and the *LLNL Environmental Compliance Manual*,[26] LLNL employees will comply with applicable federal, state, and local regulations when conducting any activity.

To supplement the guidance provided by the *LLNL Health & Safety Manual*[24] and the *LLNL Environmental Compliance Manual*,[26] a Facility Safety Procedure (FSP) will be prepared and executed to ensure efficient and safe operations within the MWMF. The FSP will provide:

- A description of an anticipated activity and its hazards and risks.
- The name of the individual responsible for ensuring compliance with the FSP.
- Instructions to be followed to implement the controls that will reduce the risks to an acceptable level.
- Information concerning any special conditions that may be present.

Additionally, any operation conducted in the MWMF that does not conform to the *LLNL Health & Safety Manual*[24] and the *LLNL Environmental Compliance Manual*[26] or to the FSP will be approved by an OSP that specifically addresses the responsibilities, hazards, and necessary controls to conduct operations safely. Other administrative preventions include ignition source limitation, Hot Work Permits, building access restrictions, workplace air sampling, signs and postings. Where necessary, Personnel Access Control Procedures will be prepared and implemented.

Everyone who enters the MWMF (including employees, visitors, and consultants) must follow the applicable requirements in the FSP. Each person is expected to protect

him / herself and others from injury or illness. Regular facility occupants are expected to guide and govern visitors and to assist new or temporary occupants in understanding and following the procedure. When there are any doubts regarding the safety of any phase of work, personnel will check with the MWMF Operations Manager.

The goal of the facility operations is to operate in the safest possible manner consistent with meeting the project goals. As such, every individual is a cognizant safety representative and is responsible for ensuring the safety of the operation in which he / she is involved. If at any time an individual feels that the safety of a system is not adequate, that individual may request an immediate shut-down until that safety issue is resolved (see *LLNL Health & Safety Manual*,[24] Section 1).

Any individual may request operational or system changes aimed at improving safety. Such change will be reviewed as to its appropriateness relative to overall systems operations and project goals. The Operations Manager is responsible for resolving these issues. Changes to the FSP will be approved by the facility Associate Director (AD). The FSP will be reviewed triennially by the authorizer and the LLNL ES&H Team Leader to establish at a minimum that its contents are appropriate and adequate for current operations.

The ES&H team for the area assists management in instituting and maintaining a minimum-risk and environmentally sound work environment. All programs, facilities, and buildings are subject to reviews and evaluations by Hazards Control and Environmental Protection personnel. Results of these reviews are forwarded to the appropriate department so that any deficiencies can be corrected. Hazards Control and Environmental Protection personnel also review the effectiveness of the ES&H teams and other Hazards Control and Environmental Protection services to ensure that they are providing the proper support to operating personnel. Records of these reviews are maintained by the Hazards Control and Environmental Protection Departments.

7.2 Quality Assurance (QA)

A QA program is established by the MWMF QAP and implementing procedures. While QA is a management responsibility, the QA Manager, through the Assurances Manager, is responsible for development and maintenance of the QA program, and assisting project personnel in its implementation.

7.3 Training

The MWMF Operations Manager is responsible for the safe operation of the MWMF. As a part of these responsibilities, the MWMF Operations Manager, through his / her staff, develops, implements, and documents a *Personnel Training and Qualification Plan*,[25] for the MWMF facilities that complies with federal, state, DOE and LLNL training policies and requirements. The training program will provide personnel with the necessary knowledge and skills to perform hazardous waste duties safely and efficiently and to ensure that hazardous- and mixed-waste activities are conducted in an environmentally sound manner. The intent of the training program is to reduce the

potential for actions that might threaten human health or the environment by ensuring that personnel working in jobs involving hazardous or mixed waste are thoroughly familiar with, and can properly perform, their duties and responsibilities. In addition to providing training in the mechanics of job functions, this program provides employees with a thorough explanation of why certain operations are performed in a prescribed manner, especially safety and emergency response operations.

The *Personnel Training and Qualification Plan*[25] will identify the requirements for training and retraining of personnel participating in or responsible for MWMF operations, and will ensure that all operations activities are carried out in a safe and effective manner. The Objectives of the plan are to:

- Establish training and qualification requirements for personnel working in the MWMF.
- Establish requirements for documentation of training.
- Define responsibilities for implementing the staffing and training requirements.
- Comply with applicable federal, state, DOE, UC and LLNL requirements.

The *Personnel Training and Qualification Plan*[25] applies to all personnel who will be working in the MWMF facilities. The MWMF Operations Manager will maintain records of each employee's specific training, job description and other records to ensure the proper level of training. This includes subjects covered in written, oral, or performance-based tests and the test results. The record system can be audited. The plan does not apply to other Building 695 personnel not specifically involved in MWMF operations. The plan will be reviewed and approved as new processes are installed in the MWMF and at least every two years. It is assumed that training courses will be periodically updated, revised, or replaced altogether due to changes in equipment, regulations, or other reasons.

The Lead Engineer is responsible for developing the process equipment training syllabus and, upon approval by line management, conducts necessary hands-on training of personnel. By virtue of developing the syllabus and conducting the training, the Lead Engineer is also trained and qualified to operate the system and/or equipment.

7.4 Calibration

The MWMF Operations Manager is responsible for the safe operation of the MWMF. As a part of these responsibilities, the MWMF Operations Manager, through his/her staff, develops, implements, and documents a calibration program for the MWMF.

The calibration plan will establish a system for the periodic calibration, preventive maintenance, and control of measuring and test equipment (M&TE) and working standards. The plan will assign responsibilities and provide a system for scheduling, tracking, and reporting of calibration activities. The objectives of the plan are to:

- Ensure the proper operation of safety related equipment that must operate with specified accuracy and precision.
- Ensure the accuracy and precision of measurement and test data required to validate the MWMF process performance.

The calibration plan will apply to equipment and activities associated with the MWMF in Building 695. It does not apply to safety equipment under the control of the LLNL Hazards Control Department. M&TE will be calibrated using written procedures. Records will be maintained to document the calibrations.

The Lead Engineer is responsible for ensuring that calibrations are performed to established procedures and that calibration records are generated and forwarded to the MWMF QA Manager.

The MWMF QA Manager is responsible for maintaining a central file of calibration records. The QA Manager is responsible for providing appropriate reports to the Lead Engineer, and for monitoring to ensure proper implementation of the calibration plan.

7.5 Maintenance

The MWMF Operations Manager is responsible for the safe operation of the MWMF. As a part of these responsibilities, the MWMF Operations Manager, through his/her staff, develops, implements, and documents a preventative maintenance plan (MP) for the MWMF.

The MP will establish a system for periodic, preventive maintenance of facility and special equipment. Preventive maintenance is important to ensure dependable and safe operation. The plan will assign responsibilities and provide a system for scheduling, tracking, and reporting of preventive maintenance activities.

The preventive maintenance activities addressed by the plan will be performed by the MWMF, Laboratory organizations such as Hazards Control and Plant Engineering (PE), and vendors. The equipment-manufacturer–supplied maintenance procedures will be used when available. When a maintenance activity is complex and supplier procedures are unavailable or inappropriate, maintenance procedures will be written and used. A system will be established to schedule and control maintenance.

The MP will apply to equipment and activities associated with the MWMF in Building 695. It does not apply to safety equipment under the control of the LLNL Hazards Control Department, which is responsible for performing preventive maintenance tasks for certain safety systems in the MWMF. Those MP records will be retained by Hazards Control. Hazards Control Department responsibilities are:

- Emergency Management Division—Testing of the MWMF fire suppression equipment.
- Safety Laboratories Division—HEPA filter testing, calibration of radiation air monitors, and radiation survey instruments.
- ES&H Team—Air flow testing, shower and eye wash checks.

PE Maintenance and Operations is responsible for the MP of various conventional facility (building) systems (e.g., fire detection and alarm, emergency power, HVAC). PE Maintenance and Operations will schedule and track preventive maintenance utilizing its own preventive maintenance program.

The Lead Engineer is responsible for ensuring that maintenance is performed to established procedures and that maintenance records are generated and forwarded to the MWMF QA Manager.

The MWMF QA Manager is responsible for maintaining a central file of MWMF maintenance records. The QA Manager is responsible for providing appropriate reports to the Lead Engineer, and for monitoring to ensure proper implementation of the MP.

7.6 Monitoring and Inspection

A monitoring and inspection program will be established by the Assurances Manager to ensure that routine, required inspections are performed and documented for MWMF systems and safety equipment to meet regulatory requirements. The goal of the monitoring and inspection program is to ensure that MWMF systems, structures, and safety equipment are in satisfactory condition and are being properly operated and maintained, and leaks and spills are promptly identified and corrected.

The monitoring and inspection plan will establish a system for periodic monitoring and inspection of facility and special equipment. All areas that handle, treat, and store hazardous and mixed waste are subject to regulatory inspection requirements. Routine inspections are therefore conducted. The inspection schedule will include weekly, daily, and daily when-in-use inspections.

Inspection checklists will specify the frequency of inspections, the area to be inspected, and the equipment to be inspected. These inspections are conducted by the MWMF operations staff. Supplemental inspections are performed by one or more of the following:

- LLNL Fire Department (fire extinguishers, fire safety).
- Security Department (locks, gates).
- Hazards Control Department (industrial safety, industrial hygiene, and health physics).

The inspection checklist will address monitoring equipment, safety and emergency equipment, security devices, and operational structural equipment relevant to health and environmental protection. The inspections will be designed to detect malfunctions, deterioration, operator errors, and discharge that may cause or lead to a release of hazardous-waste constituents to the environment, or a threat to public health. The frequency of the inspection will be based on EPA and DTSC regulatory compliance requirements where specified, the rate of possible deterioration, and the probability of an environmental or human health incident if deterioration, malfunction, or operator error goes unnoticed between inspections.

Emergency equipment will be inspected on a weekly basis. These include eye washes, showers, and fire extinguishers.

Areas which are in use and subject to spills, leaks, or rain water accumulation will be monitored or inspected daily. All container storage areas and waste staging areas in use will be inspected daily for spills. These daily inspections will be conducted at the beginning of each operating work day (excluding weekends and holidays).

Any deterioration or malfunction identified during the inspections will be documented in the daily / weekly inspection log, and will be repaired, corrected, or otherwise mitigated by LLNL on a schedule that ensures the problem does not lead to an environmental or human health hazard. Inspection records will include the following minimum information:

- Date and time of inspection.
- Name of inspector.
- Notation of observation(s) made.
- Date and nature of any repairs or other remedial action.

If a hazard is imminent or has already occurred, actions to correct the identified problem will be taken as soon as possible.

The monitoring and inspection plan will define the means by which deficiencies will be mitigated. These may include any one or combination of on-the-spot corrective action, Support Services Requests, and / or management control. Appropriate contingency plans will be established.

7.7 Documents and Records

The MWMF Operations Manager is responsible for the safe operation of the MWMF. As a part of these responsibilities, the MWMF Operations Manager, through his / her staff, develops, and implements a documents and records filing system for the MWMF.

The documents and records filing system will maintain records of all operational aspects of the facility. These records include identification and tracking of wastes handled, accident reports, bulking records, LLNL Waste Disposal Requisition (WDRs), waste analysis results, treatment records, operating logs, disposal records, land disposal restriction notifications and certifications, annual and biennial waste reports, hazardous waste manifests (orginal documents will be maintained by HWM) and inspection reports, and training, calibration and maintenance records. These records will be retained for the life of the facility.

7.8 Self-Assessment

A Directorate self-assessment program will be implemented to ensure that the MWMF complies with ES&H requirements. Self-assessments will be performed by the Directorate Assurances Manager and internally by the MWMF Assurances Manager. Self-assessments will be performed to requirements contained within the LLNL *Environmental Programs Environment Safety and Health Self-Assessment Plan*.[27]

8.0 Contingency Plan

A contingency plan is required for permitted facilities that handle hazardous and/or mixed waste. The *Contingency Plan* complements the FSP by identifying in more detail the personnel responsibilities, emergency equipment, and required actions necessary to mitigate accidents involving hazardous or mixed waste associated with the facility. The *Contingency Plan* is designed to assist personnel in minimizing hazards to human health and the environment from earthquake, fires, explosions, spills, or any release of hazardous, radioactive or mixed-waste constituents to the atmosphere, soil, or surface water from the operations conducted within the MWMF. Personnel will be instructed and prepared for potential emergencies associated with the operations of the facility. The *Contingency Plan* outlines the responsibilities and procedures to be followed in the event of an emergency at the facility and is developed in accordance with LLNL and DOE standards.

The *Contingency Plan* specifically defines the types of incidents that can be handled by trained MWMF personnel and those that must be mitigated by the Emergency Coordinator. This is accomplished by characterizing incidents as either a *small* or *large* incident as follows:

Incidents characterized as *small* meet all of the following conditions:

- The incident results in no injury or in a minor injury requiring simple first aid.
- The spill/release is of a hazardous waste, radioactive or mixed waste whose nature and potential hazards are known.
- The spill/release presents no actual or potential threat to human health or the environment.
- The spill/release can be cleaned up by one or two people in less than one hour.

Small incidents are managed by trained MWMF personnel with some support or assistance from Hazards Control or the Environmental Protection Department (EPD) as needed. The Operations Manager is immediately notified in the event of any small incident.

An incident is characterized as *large* if any one or more of the following conditions occur:

- Earthquake, fire or explosion.
- An incident that is regarded by personnel as unsafe to manage without the aid of the LLNL Fire Department.
- Spill/release of waste with hazards unfamiliar to personnel.
- Spill/release of waste that cannot immediately be identified.
- Spill/release of waste that cannot be cleaned up by two people in less than one hour.
- Injuries result that require medical treatment other than simple first aid.
- Incident requires evacuation of a building or facility.
- Spill/released waste migrates into a storm drain or sewer.

Large incidents are managed by the Emergency Coordinator who has the authority to commit all LLNL resources and the capability to obtain outside resources needed to

carry out contingency plans. The Emergency Coordinator and the Operations Manager must be immediately notified in the event of any large incident.

The *Contingency Plan* will be designed to be used in conjunction with the *LLNL Draft Emergency Plan (1993).*[28] The *LLNL Draft Emergency Plan (1993*)[28] is LLNL's site-wide *Contingency Plan* that includes implementation procedures for response to major accidents and disasters, including fires, explosions, hazardous, radioactive, or mixed material or waste releases, and other emergencies that are mitigated by the LLNL Fire Department.

9.0 Closure

Closure plans will be established to minimize the escape of residual contaminants or the migration of waste decomposition products to the environment from decommissioned equipment units. These plans are intended to eliminate the need for post-closure maintenance and control.

The MWMF Project Manager will develop and implement closure plans that include decontamination and decommissioning of MWMF equipment and facilities in compliance with established LLNL requirements, as well as all applicable federal, state and local environment, safety and health laws. These plans will describe the objectives, responsibilities, criteria, and procedures required to decontaminate the equipment and facilities associated with the MWMF. A separate plan will be provided for each major equipment unit.

All closure activities will be conducted such that threats to human health and the environment are minimized. Sampling will verify cleanliness of the equipment unit and verify that further maintenance and control are not required. Personnel participating in closure activities will have appropriate training to perform the assigned tasks.

Closure plans will contain all the information necessary to effect clean closure of the waste management unit at the end of its operating life or at any time during its active life. This will be achieved by removal of any waste inventory to a permitted mixed- or hazardous-waste treatment, disposal, and/or storage facility. The functional equipment unit, ancillary equipment, and secondary containment structure will then be decontaminated. Verification sampling will be performed for hazardous and radioactive contaminants. If contamination is found in the swipe samples, the contaminated areas will be further decontaminated, and swipe sampling repeated, or the affected structure(s)/equipment removed and isolated.

At completion of closure, hazardous- or mixed-waste constituents remaining in or about the equipment unit will not exceed established standards. All decontamination and rinse solutions and debris generated during decontamination activities will be collected, analyzed, and disposed of appropriately based on waste classification and in accordance with applicable requirements.

Closure activities will be supervised or reviewed by qualified DOE and LLNL representatives (and possibly an independent party) to certify that these activities have been performed by qualified individuals and were completed in accordance with the equipment unit closure plan.

10.0 References

1. *MWMF System Design Requirements,* LLNL, Livermore, CA, Doc. No. L-16963-1, March 1994.

2. *MWMF System Design Descriptions,* LLNL, Livermore, CA, document in preparation.

3. *MWMF Draft Final Project Plan,* LLNL, Livermore, CA, Doc. No. P-GJPO-1626, January 1994.

4. *MWMF Project Management Plan,* Livermore, CA, draft, October 1993.

5. *MWMF Quality Assurance Plan,* LLNL, Livermore, CA, Doc. No. M-078-097, October 1993.

6. *MWMF Primary Criteria,* LLNL, Livermore, CA, Doc. No. KVG-93-017, June 1993.

7. *MWMF Technology Selection & Implementation Plan,* LLNL, Livermore, CA, Doc. No. UCRL-ID-116210 Part 1, January 1994.

8. *MWMF Conceptual Design Report,* LLNL, Livermore, CA, Doc. No. UCRL-PROP-116761, April 1994.

9. *MWMF Training Plan*, LLNL, Livermore, CA, Doc. in preparation.

10. *MWMF Closure Plan*, LLNL, Livermore, CA, Doc. in preparation.

11. *MWMF Contingency Plan*, LLNL, Livermore, CA, Doc. in preparation.

12. D.P. Hoffman, L.V. Gibson, W.H. Hermes, R.E. Bastian, W.T. Davis *MWIP — Guideline for Benchmarking Thermal Treatment Systems for Low-Level Mixed Waste*, Martin Marietta Energy Systems, Inc., Focus Environmental, Inc. and Univ. of Tenn., DOE/MWIP-19, January 1994.

13. J.A.D. Stockdale, W.D. Bostick, D.P. Hoffman, Hom-Ti Lee, *MWIP — Surrogate Formulations for Thermal Treatment of Low-Level Mixed Waste, Part I: Radiological Surrogates*, Martin Marietta Energy Systems, Inc. and Oak Ridge Associated Universities, DOE/MWIP-15, January 1994.

14. W.D. Bostick, D.P. Hoffmann, J.M. Chiang, W.H. Hermes, L.V. Gibson, Jr., A.A. Richmond, J. Mayberry, G. Frazier, *MWIP — Surrogate Formulations for Thermal Treatment of Low-Level Mixed Waste, Part II: Selected Mixed Waste Treatment Project Waste Streams,* Martin Marietta Energy Systems, Inc., Science Applications International Corp., and Univ. of Tenn., DOE/MWIP-16, January 1994.

15. J.M. Chaing, W.D. Bostick, D.P. Hoffmann, W.H. Hermes, L.V. Gibson, Jr., A.A. Richmond, *MWIP — Surrogate Formulations for Thermal Treatment of Low-Level Mixed Waste, Part II: Plasma Hearth Process Testing*, Martin Marietta Energy Systems, Inc., DOE/MWIP-17, January 1994.

16. W.D. Bostick, D.P. Hoffmann, R.J. Stevenson, A.A. Richmond, D.F. Bickford, *MWIP — Surrogate Formulations for Thermal Treatment of Low-Level Mixed Waste, Part IV: Wastewater Treatment Sludges*, Martin Marietta Energy Systems, Inc. and Westinghouse Savannah River Co., DOE/MWIP-18, January 1994.

17. *Test Methods for Evaluating Solid Waste — Vol. 1A: Laboratory Manual Physical/Chemical Methods*, EPA/SW-846, November 1986.

18. *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambiant Air*, EPA/600/4/4-89/017, June 1988.

19. *Appendix A of 40 CFR 60.*

20. *Characterizing Containerized Mixed Low-Level Waste for Treatment - A Workshop Proceeding*, US EPA/US DOE EPA/600/R-94/149, May l993.

21. D.P. Hoffman, L. V. Gibson, W.H. Hermes, R.E. Bastian, A.R. Eicher , *MWIP — Data Quality Objectives: Evaluation of Thermal Treatment Processes*, Martin Marietta Energy Systems, Inc. and Focus Environmental, Inc., DOE/MWIP-22, March 1994.

22. D. Camp, J. Celeste, D. Jones, *MWMF Definition of Model Waste Streams*, LLNL, Livermore, CA, Doc. No. L-16907-1, June 1994.

23. J. Celeste, *MWMF Analysis of Initially Selected LLNL Mixed Waste Streams*, LLNL, Livermore, CA, Doc. No. L-17812-1, June 1994.

24. *LLNL Health and Safety Manual,* LLNL, Livermore, CA, Doc. No. M-010, and Supplements.

25. *MWMF Personnel Training and Qualification Plan*, LLNL, Livermore, CA, document in preparation.

26. *LLNL Environmental Compliance Manual,* LLNL, Livermore, CA, Doc. No. UCRL-MA-118090, November 1994.

27. *Environmental Programs Environment Safety and Health Self-Assessment Plan*, LLNL, Livermore, CA, document in preparation.

28. *LLNL Draft Emergency Plan 1993*, LLNL, Livermore, CA, Doc. No. UCRL-MA-113311, September 1993.

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